Research on the Impact of Flight Volume of Small and Medium Airports on Local Economy

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Abstract. Small and medium-sized airports are increasingly becoming an important part of China's civil aviation industry. The role of small and medium-sized airports in local economies has increasingly become the focus of local attention. Unlike large airports that can build airport economic zones, the economic impact of small and medium airports is not directly reflected. From the perspective of relevance and influence, this paper uses the gray model and input-output model to analyze and explore the correlation between airport operation indicators and local economic subdivision indicators for some small and medium-sized airports in China. The analysis results show that the airport flight volume factor has a significant impact on local tourism income, which has the most significant influence relationship.

Keywords: flight volume · small and medium airports · economic impact

1 Introduction

Air transportation, as a fast and safe mode of transportation, is the external environment that enables other business activities to take place. Its development is highly related to the degree of economic development. On the one hand, it depends on the development of national and regional economies, and it is also an important driving force for economic growth. Evaluate the social and economic benefits of airports that provide services for air transport, and analyze their role in social and economic growth, which purpose is to clarify the status of air transport in social and economic development, so as to better use air transport to serve economy and promote the sustainable development of the local economy.

The economic impact of air transport has been studied comprehensively at home and abroad and has formed a system. The main economic impact includes direct impacts, indirect impacts, induced impacts and catalytic impacts [1]. A convenient transportation network can reduce transportation costs, expand the service market, form economies of scale and scope, and generate savings in the form of agglomeration economies. Airports are an important part of air transportation, and the construction, operation, and surrounding adsorption capacity of airports have an impact on the local economy and

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industry. Relevant studies include the business activities that depend on the use of the functional area of the airport [2], and how the airport has boosted employment and income in the surrounding areas [3, 4]. Research on the impact of hub airports on urban and regional economies includes analyzing the different levels of economic impact of airports [5], the impact on the industrial chain and airport economy [6], and the economic characteristics and spatial layout patterns of airport economic zones [7], and the relationship between civil aviation airport construction and economic growth based on the input-output model [8]. There are few studies on small and medium-sized airports, including the use of econometric methods to study the impact of passenger growth on local income at small and medium-sized airports in Virginia, USA [9], and the study of local economic correlation and economic impact on domestic small and medium-sized airports [10].

With the rapid development of China's economy, the construction of airports in small and medium-sized cities has become a common phenomenon. In the past two decades, 129 new airports have been built, and more than 90% of the airports are small and medium-sized airports. According to the published plan, the number of airports will increase to 370 by 2025, of which the number of small and medium-sized airports will increase to 242. Small and medium-sized city airports are limited by the city's economic level and geographical resources. The routes are mainly domestic and short-range routes, and the flight density and customer throughput are relatively low. Compared with large airports, the direct and obvious economic benefits of airports such as jobs and airport industries are relatively small. In order to study the promotion effect of the opening of flights at the airports of small and medium-sized cities on the local economy, this paper conducts an empirical analysis on some small and medium-sized airports from the perspectives of relevance and impact.

2 Data Source

According to research needs and data availability, this paper selects 13 small and medium-sized cities in different regions and types as research objects, considering different city sizes, geographical locations, economic development, and traffic conditions, as shown in Table 1. The data sources include the yearbook data publicly released by each city and the airport statistical bulletin issued by the Civil Aviation Administration of China.

Table 1. Research Object Cities with Main Indicators

Province	City	GDP (2019, billion yuan)	Main Feature	Airport IATA Code	Airport throughput (thousand Person-times)
Heilongjiang	Heihe	57.9	Border Resource	HEK	215.9
				DTU	62.9
	Daqing	256.8	High-speed railway Resource	DQA	858.0
	Jixi	55.2	Border Resource-Exhausted	JXA	274.5
	Jiamusi	76.3	High-speed railway Resource-Exhausted	JMU	787.6
				FYJ	54.4
Hebei	Tangshan	689.0	High-speed railway Resource	TVS	505.2
Yunnan	Lijiang	47.3	High-speed railway Tourism	LJG	7174.0
				NLH	215.9
	Zhaotong	119.4	Resource	ZAT	369.4
	Lincang	75.9	Resource	LNJ	470.2
	Dali	137.5	High-speed railway Tourism	DLU	1773.9
Jilin	Tonghua	72.6	Resource-Exhausted	TNH	145.7
Gansu	Jinchang	34.0	Resource	JIC	194.0
	Tianshui	63.3	High-speed railway Tourism	THQ	210.6
Qinghai	Yushu	598.2	Remote	YUS	318.7

3 Analysis of the Correlation Between Flight Volume and Economy of Small and Medium-Sized Cities

The gray model aims at making a long-term fuzzy description of the development scale of things through a small amount of incomplete information for a system, and is suitable for situations where system levels and structural relationships are fuzzy, dynamic changes are random, and index data is incomplete [11]. The relationship between airport flight volume and local economy has the above-mentioned systematic characteristics and is suitable for gray models. This method is also widely used in the analysis of the relationship between ports and regional economies.

Gray relation analysis reflects the importance of each factor to the target value by studying the correlation of data, that is, the gray relation degree. The calculation process

of the gray correlation degree includes determining the analysis sequence, dimensionless variables (Eq. 1), calculating the correlation coefficient (Eq. 2) and calculating the correlation degree (Eq. 3).

$$\tilde{x}_{ij} = \frac{x_{ij} - \bar{x}_j}{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2}} \tag{1}$$

$$\zeta_i = \frac{\min\limits_i \min\limits_k |x_0(k) - x_i(k)| + \rho \max\limits_i \max\limits_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho \max\limits_i \max\limits_k |x_0(k) - x_i(k)|} \tag{2}$$

$$r_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k), k = 1, 2, \ldots, n \tag{3}$$

For the cities listed in Table 1, the city's GDP, tertiary industry output value, total import and export volume, fiscal revenue, and tourism income from 2011 to 2019 are selected as numerical indicators reflecting the local economy, The airport passenger throughput and flight frequency in the area under the jurisdiction of the above cities are taken as the analysis objects. Local economic data come from statistical yearbooks or statistical bulletins. The GDP of Heilongjiang Province can only be traced back 5 years after adjustment in 2019, so only the data from 2015–2019 are selected for calculation; Qinghai Province began to publish public finance budget revenue in 2017, so it is not included in the calculation.

The calculation results show that the gray relation degree between airport flight volume, airport throughput and local economic indicators is shown in Table 2.

It can be seen from Table II that the proportion of the number of samples whose gray correlation degree between throughput and local economic indicators and flight volume exceeds 0.75 is examined separately. The higher the proportion, the more general the correlation between the indicator and flight volume is, as shown in Fig. 1.

It can be seen from Fig. 1 that, in addition to the throughput directly related to flight volume, urban tourism income accounts for the highest proportion, followed by the output value of the tertiary industry. It can be seen that the impact of flight volume on urban economy is mainly through the promotion of tourism and service industries.

Taking Dali Airport as an example, the relationship between the normalized flight volume and local economic indicators from 2011 to 2019 is shown in Fig. 2.

According to the basic idea of the gray relational analysis method, the closer the sequence curves between factors are, the greater the degree of correlation is. In Fig. 2, except for the total amount of imports and exports, all factors have very close curves, and the degree of correlation is very high.

Based on the gray correlation analysis of the above 13 cities, the correlation between tourism income and flight volume is the strongest; at the same time, combined with the gray correlation degree over the years, it can be found that in a short period of time, the relationship between tourism income and flight volume There is no significant trend change in the gray relational degree over time, that is, there is no trend that the gray relational degree gradually decreases or increases as the number of flights increases.

Table 2. Gray Relation Degree Between Airport Flight Volume and Local Economic Indicators

Province	City	Airport Throughput	GDP	Tertiary Industry Output Value	Total Import and Export	Tourism Income	Fiscal Revenue
Hei-longjiang	Heihe	0.887	0.894	0.875	0.627	0.856	0.912
	Daqing	0.879	0.604	0.471	0.812	0.597	0.576
	Jixi	0.732	0.745	0.720	0.784	0.814	0.513
	Jiamusi	0.826	0.648	0.638	0.565	0.550	0.507
Hebei	Tangshan	0.924	0.790	0.780	0.538	0.809	0.846
Yunnan	Lijiang	0.935	0.766	0.716	0.464	0.765	0.669
	Zhaotong	0.924	0.790	0.780	0.538	0.809	0.846
	Lincang	0.832	0.726	0.836	0.701	0.715	0.646
	Dali	0.941	0.875	0.842	0.675	0.901	0.871
Jilin	Tonghua	0.948	0.513	0.763	0.725	0.826	0.500
Gansu	Jinchang	0.682	0.545	0.687	0.664	0.661	0.685
	Tianshui	0.812	0.586	0.632	0.590	0.777	0.632
Qinghai	Yushu	0.898	0.557	0.801	—	0.810	—

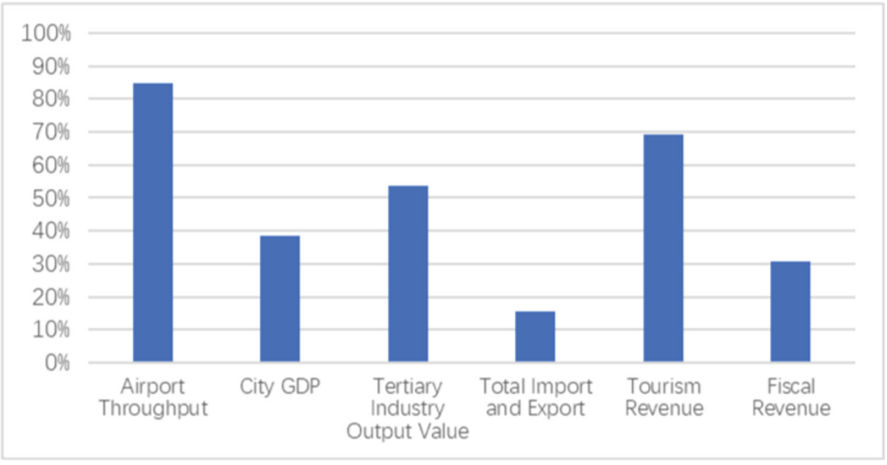

Fig. 1. Proportion of Samples with High Gray Relation Degree of Various Indicators

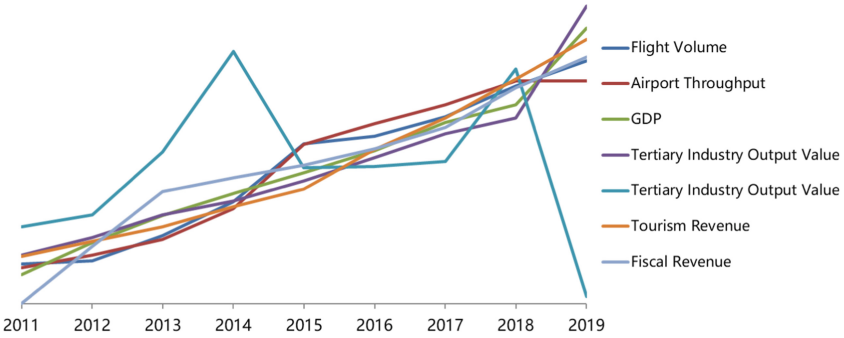

Fig. 2. Dali Airport Flight Volume and Local Economic Indicators

4 Analysis of Flight Volume and Economic Impact of Small and Medium Cities

The degree of influence is used to analyze the impact on other variables when one variable changes, and is usually analyzed using a production function, the most common production function is the Cobb-Douglas production function, as shown as Eq. 4.

$$Y = AX_1^{\beta_1} X_2^{\beta_2} \ldots X_n^{\beta_n} \tag{4}$$

In order to eliminate the collinear relationship between airport flight throughput and navigable city variables, the original data are preprocessed by principal component analysis.

The process of principal component analysis includes sample data standardization processing (Eq. 5), correlation coefficient calculation (Eq. 6) and eigenvector calculation (Eq. 7).

$$X = \frac{x_{ij} - \bar{x}_j}{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2}}, (i = 1, 2, \cdots, n; j = 1, 2, \cdots, m) \tag{5}$$

$$R = \frac{1}{m-1} X'X \tag{6}$$

$$D = V^{-1}RV \tag{7}$$

The eigenvalues obtained by principal component analysis are used to judge principal component variables, and the eigenvectors are used to convert standardized variables into principal component variables.

The variables in the sample data are transformed into standard variables through principal component analysis, and the principal component variables are obtained. Complete the logarithmic regression of the principal component variables (Eq. 8), and de-standardize the regression results to obtain the coefficient of each sample variable (Eq. 9).

$$\ln ZY = \ln A + \beta_1 \ln ZX_1 \tag{8}$$

$$\ln ZX_1 = \gamma_1 \ln X_1 + \gamma_2 \ln X_2 + \gamma_3 \ln X_3 + \gamma_0 \tag{9}$$

In Eq. 8 $ZX1$ indicates principal component variable, ZY indicates city tourism income, In Eq. 9, X_1, X_2, X_3 indicate airport flight volume variable, throughput variable, access city number variable respectively, and the coefficients corresponding to the variables refer to the corresponding impact levels.

Taking Heihe as an example, principal component analysis shows that the first principal component contains 91% of the information and can be used for regression; the coefficients of flight volume, throughput and navigable cities in the first principal component are 0.55, 0.60 and 0.58 respectively. After regressing the first principal component and urban income, the correlation coefficient is 0.84, and the P value is $0.029 < 0.05$, passing the significance test, indicating that there is a strong correlation between the first principal component and urban tourism income. After de-standardizing the regression results combined with the principal component coefficients, the elasticity of flight volume, throughput, and access city number to tourism income can be obtained as 0.38, 0.31, and 0.2. Thus, for every 1% increase in flight volume, tourism income will increase by 0.38%, and at the same time, the positive impact of flight volume is greater than that of throughput and navigable cities.

For the cities listed in Table 1, select the corresponding data from 2011 to 2019 for analysis, considering the validity of the data, Heilongjiang Province only selects the data from 2015 to 2019 for calculation. The construction of Tangshan Airport was suspended for 2 months in 2019, and the year is not taken into consideration either. The calculated impact of city airport flight volume, throughput, and access city number on tourism income is shown in Table 3.

It can be seen from Table 3 that for most cities, flight volume has the greatest positive impact on tourism income, followed by throughput.

The relationship between the flight volume elasticity coefficient and the city's tourism income is shown in Fig. 3. The red points in the figure reflect that the impact of the city's flight volume is less than the throughput Influence.

Figure 3 shows that for airports with higher urban tourism income, the elasticity of flight volume is smaller. Therefore, for cities where the tourism industry is still developing, the use of regional airliners to increase the frequency of flights is more meaningful for the city's tourism income than simply taking throughput as an indicator.

Table 3. Impact of Urban Airport Transportation on Tourism Revenue

Province	City	Tourism Income (2019, billion yuan)	Flight Volume Elastic coefficient	Airport Throughput Elastic coefficient	Access City Number Elastic coefficient
Hei-longjiang	Heihe	11.5	0.38	0.31	0.21
	Daqing	15.6	0.45	0.31	0.27
	Jixi	8.3	0.47	0.82	0.55
	Jiamusi	3.3	0.51	0.36	0.36
Hebei	Tangshan	73.8	0.36	0.35	0.33
Yunnan	Lijiang	107.8	0.60	0.50	0.40
	Zhaotong	36.4	0.34	0.35	0.32
	Lincang	34.0	0.60	0.57	0.50
	Dali	94.2	0.32	0.30	0.28
Jilin	Tonghua	32.1	0.66	0.45	0.76
Gansu	Jinchang	3.4	0.78	0.54	-0.52
	Tianshui	30.3	0.18	0.16	0.30
Qinghai	Yushu	0.9	0.60	0.64	0.60

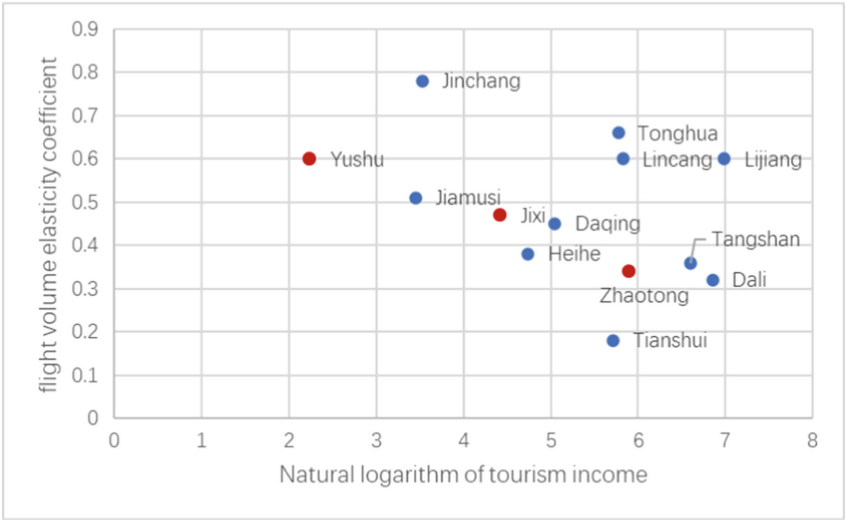

Fig. 3. Flight Volume Elasticity and Urban Tourism Income

5 Conclusion

This paper takes 13 small and medium-sized cities in different regions of China as the research objects, and selects the urban GDP, tertiary industry output value, total import and export volume, fiscal revenue, and tourism income from 2011 to 2019 as the numerical indicators reflecting the local economy, and Carry out correlation and impact analysis on airport passenger throughput, flight volume and access city number in the area under the jurisdiction of the city. The results show that the gray correlation between urban tourism income and airport flight volume is the highest, and the flight volume has the strongest effect on urban tourism income. At the same time, there is a large gap in tourism income between different cities, and the impact of flight volume is more significant for cities with relatively low tourism income.

References

1. Economic Contribution of Civil Aviation; Circular 292; International Civil Aviation Organization: Montréal, QC, Canada, 2002.
2. Neuwirth R M, Weisbrod G E. Airport area economic development model: model and case study [C]//Compendium of Technical Papers, 64th ITE Annual MeetingInstitute of Transportation Engineers (ITE). 1994.
3. Hakfoort J, Poot T, Rietveld P. The regional economic impact of an airport: The case of Amsterdam Schiphol Airport [J]. Regional Studies, 2001, 35(7): 595-604.
4. Huddleston J R, Pangotra P P. Regional and local economic impacts of transportation investments [J]. Transportation Quarterly, 1990, 44(4)
5. Song W, Yang K. The impacts of air transportation and airport on regional economic development [J]. Scientia Geographica Sinica, 2006, 26(6): 657.
6. Zhou Y. Research on the Influence of Capital Airport on Regional Industrial Structure [D]. Beijing Jiaotong University, 2012.
7. Dong J. Research on Industrial Characteristics and Spatial Layout Mode of Airport Economic Zone [D]. Changan University, 2008.
8. Rui H. Research on the impact of large-scale transportation infrastructure construction on regional economic growth [D]. Fudan University, 2009.
9. Button K, Doh S, Yuan J. The role of small airports in economic development [J]. Journal of airport management, 2010, 4(2): 125-136.
10. Qi Y. Research on the Influence of Small and Medium Airports on Regional Economy [D]. Civil Aviation Flight University of China,2015.
11. Tan X, Deng J. Grey connected analysis: a new method of multifactor statistical analysis [J]. Statistical Research, 1995, 12(3): 46-48.