Journal of Globe Scientific Reports

journal homepage: www.journal-gsr.online

Paper Type: Original Article

Analysis of Xinjiang Regional Airport Aviation Network Connectivity Drivers under Industrial Convergence

Yanwei Li[1], Dan Zhao[1*]

1.Civil Aviation University of China, Civil Aviation University of China, Tianjin, China

Abstract

Demand for air transportation determines the connectivity of routes between airports and influences the development of airline route networks. The demand for air transportation is affected by many factors, and socio-economic factors are one of the most important ones. In this paper, we use input-output analysis to explore the correlation between the air transportation industry and the three industries at the national level and Xinjiang level, and find that the tertiary industry has the highest direct demand for air transportation. Thus, we construct an indicator system for considering the demand for air transportation, and through the grey correlation analysis method, we find that the integration of Xinjiang's air transportation industry with the tertiary industry is in the friction stage, and at the same time, we select the contribution rate of the tertiary industry, the number of tourists, the total retail sales of consumer goods, and the passenger traffic volume of roads and railroads as the important drivers of the connectivity of Xinjiang's regional airports to the aviation network, and then we use these four drivers as the drivers for priority connectivity of the air routes of Xinjiang regional airports. The simulation network is constructed by prioritizing the connectivity of the network, and compared with the real network, it is found that the number of tourists, the passenger traffic volume of road and railroad, and the total retail sales of social consumer goods are more important drivers for the connectivity of the aviation network.

Keywords: Industry convergence, Aviation networks, Driving force

0 Introduction

Xinjiang has an important strategic positioning in the overall situation of the

country, the development of civil aviation also has certain advantages, the interaction between the regional economy and air transportation, mutual influence. The interaction and influence between the regional economy and the air transportation industry, how the related industries and the air transportation industry interact and develop, how the industrial integration drives the airport aviation network connection, and how to determine the driving role of the driving factors on the aviation network connection need to be studied in depth.

Scholars at home and abroad have conducted in-depth research on air transportation and economic development. Liu Hongkun et al. (2009)[1] found that the development of urban tertiary industry is the main driving factor for the evolution and development of route network. Han Hong (2009)[2] Through the input-output analysis of the impact of the national economy and its industrial sectors on the civil aviation transportation industry, it is found that the civil aviation transportation industry has an obvious bottleneck nature and should be given priority for development. The development of tourism has a large pulling effect on the air passenger transportation industry. Zeng Xiaozhou et al. (2012)[3] showed through gravity model that regional socio-economic changes caused by passenger traffic on the routes are the driving force for the evolution of connectivity of the route network.Chi et al. (2013)[4] explored the relationship between passenger and cargo air transport services and economic growth in the short run and the long run relying on autoregressive distributional lag modeling.Maparu et al. (2017)[5] explored through Granger causality test the relationship between causal relationship between air transportation and economic development in the short and long run. Feng Yu and Ge Torch (2019)[6] The driving force of Xinjiang's feeder air network connection was analyzed, and it was concluded that the output value of the tertiary industry in the city where the airport is located is the main driving factor of Xinjiang's feeder air transportation network connection. Yanwei Li et al. (2020)[7] used the fuzzy set qualitative comparative analysis (fsQCA) method to try to explore the "joint effect" of multiple external factors, such as macroeconomics, on the route network connectivity of transportation airports. Zhang Guoqiang (2023)[8] believes that economic growth is the originator of air transportation demand, and under the high-quality

development, the economy still maintains moderate growth, and the scale of social products and services increases, which brings about an increase in the demand for air transportation; with the upgrading of the industrial structure, the increase of high-value-added products and productive services, and changes in the transportation structure, which increases the social demand for air transportation.

Most of the existing studies on the correlation between industry and air transportation are from the correlation between macro external factors such as GDP, population and output value and air network, the relationship between civil aviation transportation industry and industrial structure, or studying the impact of a single industry (tourism) on the demand for air transportation, but there is a lack of studies based on the perspective of industrial integration to explore the paths of its impact on the air network connectivity. Therefore, from the perspective of the integration of the air transportation industry and other industries in Xinjiang region, it is important to analyze the driving force of aviation network connection under industrial integration to optimize the aviation network connection.

1 Path analysis of aviation network connectivity under industry convergence

1.1 Input-output analysis

Input-output analysis is an important tool to assess the degree of correlation between various industries of the national economy and their mutual influence, and it can analyze the intrinsic connection between various industries in terms of supply and demand, input and output[9] . In this paper, key indicators such as direct consumption coefficient, complete consumption coefficient and indirect consumption coefficient are selected to analyze the interconnection between the air transportation industry and the three industries in depth, and the influence coefficient and induction coefficient are calculated to reveal the industrial ripple effect of the air transportation industry in the national economy.

1.2 Data processing and analysis

This paper adopts the input-output table of competitive (sector 149) and non-competitive (sector 42) in 2017, and the input-output table of sector 42 in Xinjiang in 2017, and the input-output table of sector 149 compiled by TEDA Forecasting (Beijing) Software Co. on the basis of the input-output table of sector 42, combined with the regional macro and sub-industry breakdown data of the State Bureau of Statistics of China and the Bureau of Statistics of Xinjiang, and the application of input-output theory. The input-output table of 149 sectors was compiled by TEDA Forecast (Beijing) Software Co.

For the convenience of analysis and comparison, according to the industry classification standard of the National Economic Industry Classification, air passenger transportation and air cargo transportation and transportation support activities in sector 149 are combined into air transportation as a separate item, and the rest of the industries are combined into the three industries according to the industry classification, which is finally combined into the input-output table of air transportation and the three industries to further reflect the correlation between air transportation and the three industries.

1.3 Correlation analysis of Xinjiang's air transportation industry and the three industries

1.3.1 Analysis of the air transportation industry in relation to the national economy

The structure of the backward and forward correlations between the air transport industry and the national economy as a whole, analyzed in terms of influence and influence coefficients, induction and induction coefficients, is shown in Table 1.1, and the air transport industry comprises air passenger transport and air cargo transport and transport support activities.

Table 1.1 Consumption of three industries by air transportation, 2017

Data range	air transportation industry	backward linkage		forward linkage	
		Impact factor	Ranking (sector 149)	Sensitivity factor	Ranking (sector 149)
nationwide	Air Passenger	0.981269164	85	0.640096766	78

	Transportation Air cargo transportation and transport support activities	0.940746537	92	0.626802067	80
Xinjiang	Air Passenger Transportation	1.105395658	42	0.641476305	81
	Air cargo transportation and transport support activities	1.00324696	77	0.745498349	60

At the national level, the forward linkage inductance rankings of air passenger transportation and air cargo transportation and transportation support activities are higher than the backward linkage influence rankings in many industries, and their role as inputs to the national economy is greater than their role as pulling forces for the national economy as a production sector. The influence ranking of backward linkage of air passenger transportation in Xinjiang is significantly higher than the ranking of forward linkage inductance, and its pulling effect on the economy is more obvious, while the forward linkage inductance ranking of air cargo transportation and transportation support activities is higher than the backward linkage influence ranking, indicating that its driving effect in the national economy is higher than its pulling effect.

1.3.2 Analysis of Air Transportation Industry and Tertiary Industry Linkages

As can be seen from the consumption of the air transportation industry on the three industries, the development of the air transportation industry at the national level consumes the secondary industry the most; the consumption of air transportation on the three industries at the Xinjiang level has the same characteristics as that at the national level, and the consumption of the air transportation industry on the secondary industry is more significant.

Table 1.2 Consumption of three industries by the air transportation industry, 2017

Data range	Industry type	Direct consumption factor	Indirect consumption factor	Full consumption factor
nationwide	primary sector of industry	0.000342077	0.05937384	0.059715916
	secondary sector of industry	0.281858836	0.703226942	0.985085778
	tertiary sector of industry	0.247226594	0.351354785	0.598581379

Xinjiang	primary sector of industry	0.002863744	0.065827358	0.068691103
	secondary sector of industry	0.471178393	0.933719221	1.404897613
	tertiary sector of industry	0.134134015	0.315822159	0.449956174

The changing characteristics of the demand for air transportation in different sectors are different, as shown in Table 1.3 Demand for Air Transportation in Three Industries, the demand for air transportation is higher in the tertiary industry at the national level. The Xinjiang level has the same trend as the national trend, with higher direct demand for air transport in the tertiary industry, which coincides with the trend of gradually increasing the weight of the tertiary industry structure in Xinjiang through industrial restructuring, and is also a manifestation of the economic structure moving towards advancedization.

Table 1.3 Demand for Air Transportation by Three Industries, 2017

Data range	Air transportation requirements	primary sector of industry	secondary sector of industry	tertiary sector of industry
nationwide	Direct consumption factor	0.00145044	0.001425812	0.007367663
	Indirect consumption factor	0.003635657	0.007367984	0.006469675
	Full consumption factor	0.005086098	0.008793796	0.013837338
Xinjiang	Direct consumption factor	0.001686317	0.001574829	0.004764396
	Indirect consumption factor	0.003183104	0.005324377	0.004236871
	Full consumption factor	0.004869422	0.006899206	0.009001267

In summary, the development of Xinjiang's air transportation industry has a more obvious pulling effect on the regional economy. Air transportation and the three industries reflect different association characteristics, Xinjiang air transportation industry has the most direct consumption to the secondary industry, and the tertiary industry has the highest direct demand to the air transportation industry. The secondary industry plays a great role in safeguarding the air transportation industry, escorting airport construction and aviation network connection. Based on the consideration of air transportation demand, the following section will focus on analyzing the driving force of the integration development of the tertiary industry, which has the highest demand for air transportation, and the air transportation industry on the air network connection.

1.4 Integration and Development of Xinjiang's Air Transportation Industry and Tertiary Industry

As the tertiary industry with the highest demand for air transportation in Xinjiang, the main mechanisms for the integration and development of the two mainly include: service business integration, in which other service industries in the tertiary industry cooperate with air transportation enterprises to expand their transportation business; market-driven integration, in which the market demand prompts air transportation enterprises to innovate their service modes, for example, launching the "aviation + tourism" one-stop service; technological innovation integration, in which technological progress (such as big data, cloud computing and artificial intelligence) promotes information sharing and resource integration, and promotes service mode innovation. Market-driven integration, where market demand prompts air transport enterprises to innovate their service models, such as the introduction of "aviation + tourism" one-stop services; and integration of scientific and technological innovation, where scientific and technological progress (such as big data, cloud computing and artificial intelligence) promotes the sharing of information and the integration of resources, and facilitates innovation in service models.

The main features of the integration and development of Xinjiang's air transportation industry with other service industries in the tertiary sector are as follows: integration with the tourism industry, air transportation has injected vitality into Xinjiang's tourism industry, and improved airport infrastructure and route networks have enhanced the attractiveness of tourism, for example, the opening of the "Silk Road Rainbow" tourism route by China Southern Airlines; integration with multimodal transportation has improved accessibility. In terms of integration with information services, the informatization of the air transport industry provides data resources for the information services industry; in terms of integration with the cargo industry, air transport provides logistical support, which enables the development of freight transport and e-commerce in Xinjiang, for example, the "Xinjiang Goodies" platform uses air logistics to expand its market.

1.5 Xinjiang Airport Aviation Network Connection Driving Path Analysis

Based on the analysis of the status quo of industrial integration in the previous section, the conceptual model for constructing the driving path of industrial integration for airport aviation network connection is shown in Figure 1-1. Under the environment that the state vigorously promotes innovation in all industries and macro policy support, regional economic development and market transportation demand drive the integration of the air transportation industry with other industries. The integration of the third industry with the air transportation industry through scientific and technological innovation, market-driven and service business paths can further trigger changes in aviation demand. The result of these three modes of integration and development is reflected in changes in airport passenger and cargo throughput. Integration and development will bring more passengers and cargo, leading to an increase in airport passenger and cargo throughput, and the increase in throughput will lead to an increase in airport traffic, which in turn will affect the opening and connection of airport routes, as well as the layout of airports and the construction of infrastructure. With the construction of airports and the improvement of infrastructure, the aviation network structure of airports will evolve and change the position of airports in the aviation network. The evolution of the aviation network structure will further enhance the accessibility of the aviation network and provide new impetus for the future development of the air transportation industry, forming a virtuous circle that ultimately promotes the development of the regional economy.

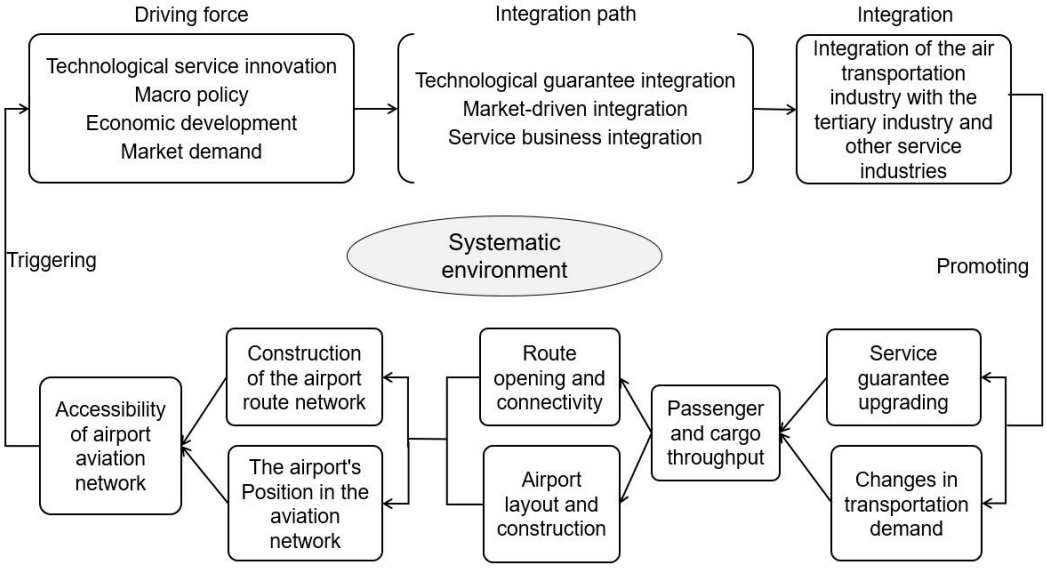

Figure 1-1 Driving Paths of Industrial Convergence for Airport Aviation Network Connectivity

2 Selection of Drivers for Aviation Network Connectivity of Xinjiang Regional Airports

Based on the driving mechanism of industrial integration on aviation network connectivity and accessibility in Figure 1-1, industrial integration affects aviation network accessibility, but it is not clear about the intersection of industrial integration, so this paper tries to analyze the stage of industrial integration of aviation transportation industry in Xinjiang regional airports by applying gray correlation degree method, and find the main factors of integration and intersection as the main driving factors of aviation network connectivity.

2.1 Gray correlation analysis

Gray correlation analysis was proposed by Professor Deng Julong of Huazhong University of Technology in 1982[10] . It is an analytical method that reflects the degree of convergence between factors based on data. The method uses the degree of correlation as a measure of the closeness of the relationship between two factors, and determines whether the connection is close or not by analyzing the degree of geometric similarity between the reference sequence and the comparison sequence curves in the

system. The advantages of this method are that it is simple and convenient to calculate, can reduce errors, and can reflect the overall situation through a small sample, which is a reasonable and effective analysis method[11] .

By comparing the size of the correlation of each indicator ξ_{0i} , the value of ξ_{0i} ranges from $0<\xi_{0i} \leq 1$, and the larger the value of ξ_{0i} , the larger the correlation, and vice versa. The details are shown in Table 2.1.

Table 2.1 Relevance, Coupling Classification

The correlation coefficient ξ_{0i}	affiliate relationship	coupling relationship
$0.85 <\xi_{0i} \leq 1$	Extremely high correlation state	coupling phase
$0.65 <\xi_{0i} \leq 0.85$	higher bound state (math.)	break-in period
$0.35 <\xi_{0i} \leq 0.65$	Medium association status	antagonistic phase
$\xi_{0i} \leq 0.35$	Lower Linked State	separation phase

2.2 Construction of a system of indicators to consider demand for air transportation

Passenger throughput (Y1) and cargo and mail throughput (Y2) are selected as indicators to measure the development level of the air transportation industry. A total of 12 (X1-X12) indicators were selected to measure the development indicators of the tertiary industry, and at the same time, as the driving factors of the aviation network connection including: the overall perspective of the tertiary industry, the perspective of the freight industry, the perspective of the tourism industry, the perspective of the other transportation industries, and the perspective of the scientific research and technical service industry were analyzed, and the indicator system is shown in Figure 2-1.

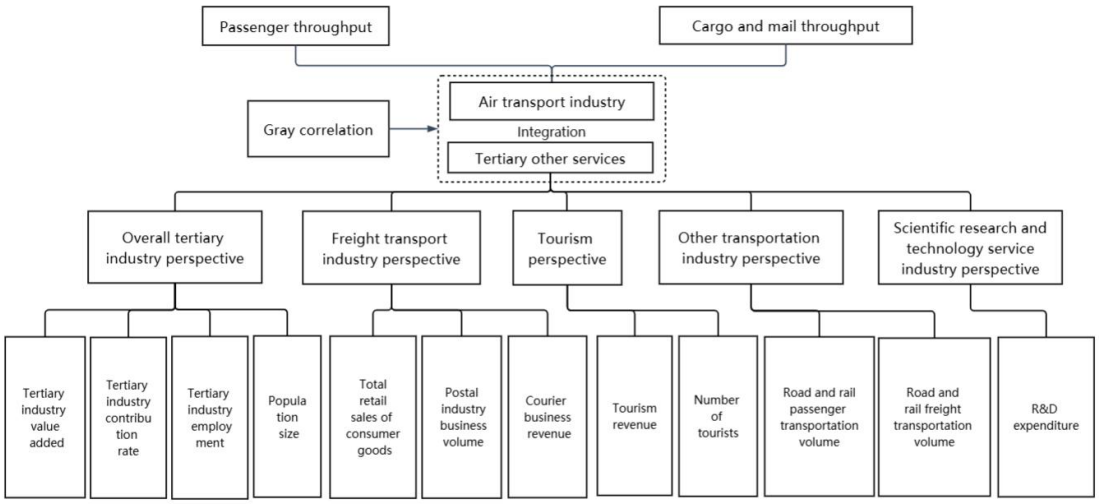

Figure 2-1 Construction of the indicator system considering the demand for air transportation

2.3 Results of the selection of indicators of aviation network connectivity drivers

Obtain overall passenger throughput and cargo and mail throughput data for Xinjiang airports from the National Civil Transportation Airport Production Statistics Bulletin published by the Civil Aviation Administration of China (CAAC) for 2019-2023. Get the overall tertiary industry related index data of Xinjiang in 2023 from the National Economic and Social Development Statistics Bulletin published by Xinjiang Statistics.

Table 2.2 Raw data for relevant indicators, 2019-2023

arrange in order	norm	2019	2020	2021	2022	2023
Y1	Passenger throughput (10,000)	3758	1896	2766	1679	4095
Y2	Cargo and mail throughput (tons)	21.69	16.08	17.78	12.25	20.47
X1	Value added of tertiary industry (billion yuan)	7031	7033	7657	7976	8673
X2	Tertiary sector contribution (%)	68.2	1.3	50.5	23.4	48.4
X3	Population size (10,000)	2559	2590	2589	2587	2598
X4	Employment in the tertiary sector (10,000 persons)	664.79	705	710	631	-
X5	Per capita disposable income of urban residents (yuan)	34664	34838	37642	38410	40578
X6	Total retail sales of consumer goods (billion dollars)	3617	3063	3585	3240	3850
X7	Volume of business in the postal sector (billions of dollars)	43.02	45.07	46.18	46.21	69.06
X8	Revenue from express delivery services (billions of dollars)	28.05	30.25	37.63	34.87	62.04
X9	Tourism revenue (billions of dollars)	3594	991	1416	907	2852
X10	Number of tourists (10,000)	21121	15805	19057	12230	26191

X11	Freight transported by road and rail (tons)	84478	57782	86779	87967	104283
X12	Passenger traffic on roads and railroads (million passengers)	20235	1835	16941	12729	21101
X13	Expenditures on R&D (billions of dollars)	64.1	61.57	78.31	90.98	-

The raw data are dimensionless processed to as the results in Table 2.3. Calculated data show that the average gray correlation ξ_{0i} = 0.709 between passenger throughput and the indicators of the third industry-related influencing factors, indicating that the selected third industry-related indicators have a relatively close connection with the passenger throughput of Xinjiang airport. From the gray correlation of each evaluation index, the correlation between the passenger throughput of highway and railroad is the highest, 0.820; followed by the number of tourists, with a correlation of 0.813; and again the contribution rate of the tertiary industry, with a correlation of 0.794.

Table 2.3 Correlation between passenger throughput and related influencing factors

norm	2019	2020	2021	2022	2023	Average correlation
Value added of tertiary industry	1	0.531	0.614	0.449	0.796	0.678
Tertiary sector contribution	1	0.536	0.992	0.844	0.596	0.794
Size of population	1	0.525	0.671	0.499	0.883	0.715
Employment in the third sector	1	0.502	0.628	0.528	-	0.665
Per capita disposable income of urban residents	1	0.529	0.616	0.459	0.874	0.695
Total retail sales of consumer goods	1	0.621	0.687	0.555	0.957	0.764
Volume of business in the postal sector	1	0.508	0.624	0.472	0.521	0.625
Revenue from express delivery operations	1	0.494	0.481	0.413	0.333	0.544
tourism revenue	1	0.710	0.621	0.743	0.655	0.746
number of visitors	1	0.697	0.771	0.809	0.789	0.813
Freight transported by road and rail	1	0.758	0.658	0.486	0.795	0.739
Passenger traffic by road and rail	1	0.575	0.847	0.755	0.923	0.820
Expenditure on research and development	1	0.552	0.536	0.366	-	0.613
Average correlation of passenger transportation						0.709

Taking cargo and mail throughput as (Y2) as the parent series to calculate the correlation obtained as the results in Table 2.4. Calculated data show that the average

gray correlation ξ_{0i} =0.758 between cargo and mail throughput and the indicators of the relevant influencing factors of the tertiary industry, indicating that the selected indicators related to the tertiary industry have a relatively close connection with the cargo and mail throughput of Xinjiang Airport. From the gray correlation of each evaluation index, the number of tourists has the highest correlation of 0.907, followed by the passenger traffic volume of roads and railroads, with a correlation of 0.848, and the total retail sales of consumer goods, with a correlation of 0.828.

Table 2.4 Correlation between cargo and mail throughput and related influencing factors

norm	2019	2020	2021	2022	2023	Average correlation
Value added of tertiary industry	1	0.710	0.702	0.527	0.686	0.725
Tertiary sector contribution	1	0.467	0.889	0.741	0.730	0.766
Size of population	1	0.701	0.768	0.587	0.899	0.791
Employment in the third sector	1	0.665	0.719	0.623	-	0.752
Per capita disposable income of urban residents	1	0.706	0.704	0.539	0.736	0.737
Total retail sales of consumer goods	1	0.857	0.787	0.657	0.840	0.828
Volume of business in the postal sector	1	0.674	0.714	0.555	0.489	0.686
Revenue from express delivery operations	1	0.653	0.549	0.483	0.333	0.604
tourism revenue	1	0.577	0.598	0.670	0.808	0.731
number of visitors	1	0.989	0.885	0.978	0.682	0.907
Freight transported by road and rail	1	0.917	0.753	0.571	0.686	0.785
Passenger traffic by road and rail	1	0.494	0.973	0.908	0.865	0.848
Expenditure on research and development	1	0.743	0.612	0.426	-	0.695
Average correlation of cargo and mail transportation						0.758

By calculating the average correlation coefficient of the correlation indicators for passenger throughput and cargo and mail throughput, the comprehensive correlation size of these indicators is finally obtained, and the correlation indicators are ranked, so as to determine the importance of the correlation indicators. The results are shown in Table 2.5.

Table 2.5 Average correlation between air transportation and indicators related to the tertiary sector

norm	Average traveler	Average	Average	rankings

	relevance	correlation of cargo and mail	correlation	
Value added of tertiary industry	0.678	0.725	0.701	10
Tertiary sector contribution	0.794	0.766	0.780	4
Size of population	0.715	0.791	0.753	6
Employment in the third sector	0.665	0.752	0.708	9
Per capita disposable income of urban residents	0.695	0.737	0.716	8
Total retail sales of consumer goods	0.764	0.828	0.796	3
Volume of business in the postal sector	0.625	0.686	0.656	11
Revenue from express delivery operations	0.544	0.604	0.574	13
tourism revenue	0.746	0.731	0.738	7
number of visitors	0.813	0.907	0.860	1
Freight transported by road and rail	0.739	0.785	0.762	5
Passenger traffic by road and rail	0.820	0.848	0.834	2
Expenditure on research and development	0.613	0.695	0.654	12
Correlation of indicators			0.733	

Finally, the average gray correlation ξ_{0i} = 0.733 of the indexes of air transport development and tertiary industrial convergence in Xinjiang airport, when $0.65 < \xi_{0i} \leq 0.85$ is a high correlation state, the correlation is strong, according to the interpretation of the results, it indicates that the integration of air transport and tertiary industry in Xinjiang airport is in the stage of friction. From the gray correlation of each evaluation index, the number of tourists received has the highest correlation of 0.860; followed by the passenger traffic volume of road and railroad with the correlation of 0.834; followed by the total retail sales of consumer goods with the correlation of 0.764; and the fourth is the contribution rate of the tertiary industry with the correlation of 0.780.

3 Analysis of Driving Forces for Aviation Network Connectivity at Xinjiang Regional Airports

The top four indicators of correlation: the contribution rate of the tertiary industry, the number of tourists, the total retail sales of consumer goods, and the passenger

volume of roads and railroads are selected as four drivers to analyze the strength of their influence on the aviation network connection of Xinjiang's regional airports, and the following are the analytical methods and models.

Within the framework of a general priority connection network model, the network model is constructed with the contribution rate of the tertiary industry, the number of tourists, the total retail sales of social consumer goods, and the passenger traffic volume of roads and railroads as the factors of the priority connection probability, respectively. The constructed model has the same scale and node attributes as the actual Xinjiang airport aviation network sample, and the same tertiary industry contribution rate, number of tourists, total retail sales of social consumer goods, and road and rail passenger traffic as the real network nodes. The statistical characteristics of the constructed network are analyzed, and if it has the statistical properties close to the real network, then it is considered that these factors have a significant impact on the structure of the aviation network of Xinjiang regional airports, otherwise, it is considered that these factors do not have a significant impact on the structure of the aviation network of Xinjiang regional airports.

Considering only the effect of a single driver of the airport city on aviation network connectivity, if a new connecting edge is established between two pre-existing airport nodes i and j, the probability that these two nodes are selected is:

$$\prod_{ij} = \frac{Y_i}{\sum_n Y_n} \times \frac{Y_j}{\sum_n Y_n - Y_i} \tag{3.1}$$

where Y is the airport city driver indicator and n is the number of node airports.

3.1 Impact of tertiary sector contribution on aviation network connectivity

According to the formula (3.1) to substitute Y as the tertiary industry contribution rate of the airport city for data simulation, can obtain the simulation network degree value of each node, and derive the simulation of the simulation network degree distribution simulation map. Comparing it with the real network node degree value distribution graph, as shown in Figure 3.1, there is not much agreement with the real network degree value distribution graph comparison.

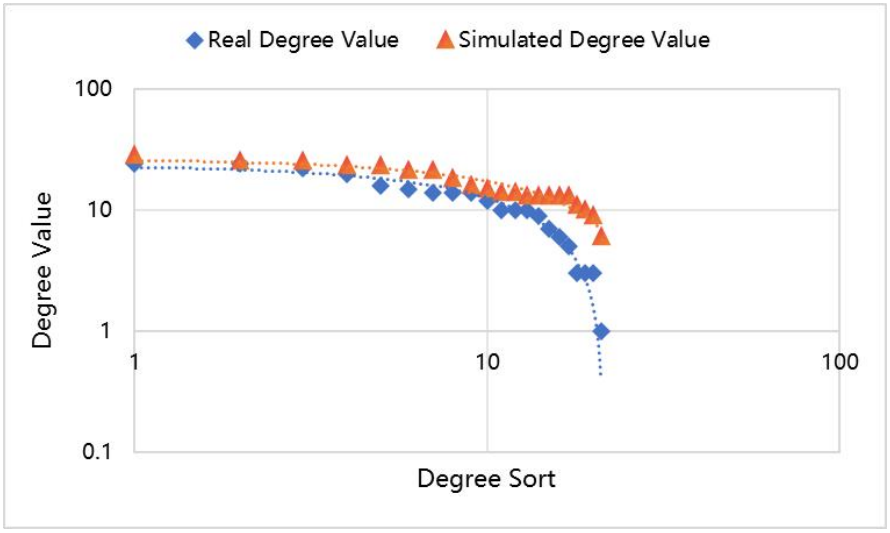

Figure 3.1 Simulated Network vs. Real Network with Tertiary Contribution as Priority Connection

3.2 Impact of tourist arrivals on air network connectivity

Simulating the data by substituting Y for the number of tourists in the airport city according to equation (3.1), the degree values of each node of the simulation network can be obtained, and the simulation map of the degree distribution of the simulation network is derived. Comparing it with the real network node degree value distribution graph, as shown in Figure 3.2, the curve fit is relatively good.

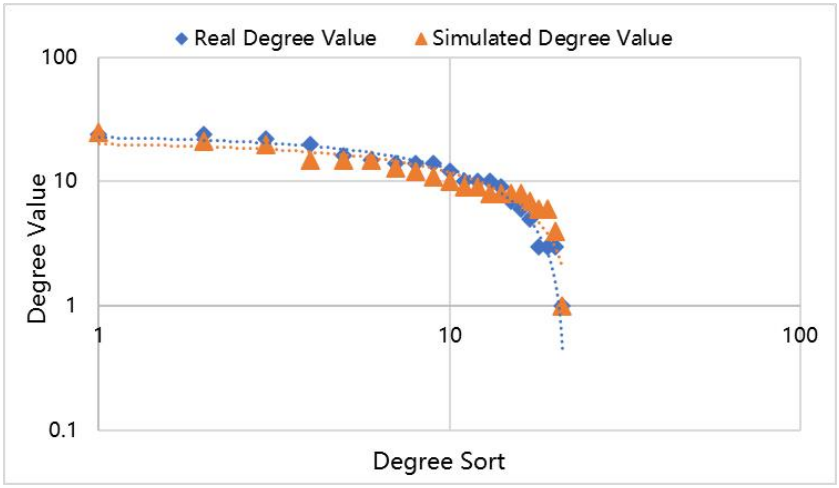

Fig. 3.2 Simulated network with number of visitors as a priority connection vs. real network

3.3 Impact of total retail sales of consumer goods on aviation network connectivity

In accordance with equation (3.1) substituting Y for total retail sales of consumer goods in the airport city for data simulation, the degree values of each node of the

simulation network can be obtained and the simulation network degree distribution simulation graph is derived. Comparing it with the real network node degree value distribution graph, as shown in Figure 3.3, the curve fit is relatively good.

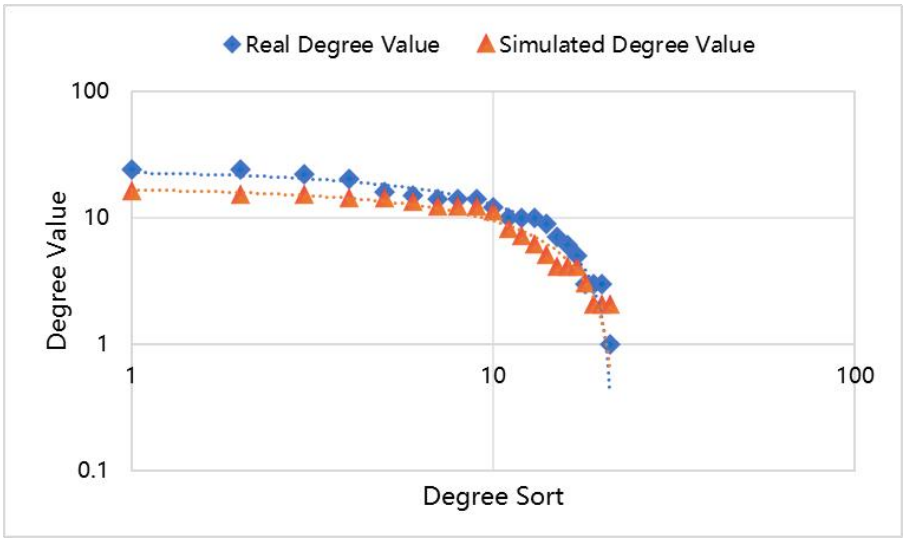

Figure 3.3 Simulated network with total retail sales of consumer goods as a prioritized connection vs. real network

3.4 Impact of road and rail passenger traffic on air network connectivity

In accordance with equation (3.1), Y is substituted for the airport city road and rail passenger traffic for data simulation, the simulation network node degree values can be obtained, and the simulation network degree distribution simulation map is derived. Compare it with the real network node degree value distribution graph, as shown in Figure 3.4, the fitting effect is relatively good.

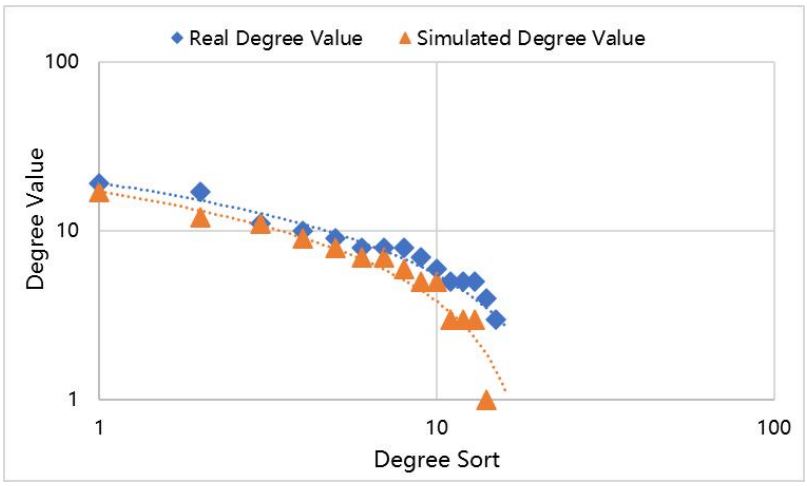

Figure 3.4 Comparison between simulated and real networks with road and rail passenger traffic as priority connections

3.5 Comparison of Drivers of Drivers

The root mean square error is used to compare the simulated network with the true network, the smaller the root mean square error the greater the driver drive. The root mean square error is the square root of the ratio of the square of the deviation of the predicted value from the true value to the number of observations, n. In practical measurements, the number of observations, n, is always finite, and the true value can only be replaced by the most trustworthy (best) value. The root mean square error measures the deviation of the observed value from the true value and is given by:

$$RMSE=sqrt([(x_1 -x)^{\wedge}2 +(x_2 -x)^{\wedge}2 +..... (x_n -x)^{\wedge}2]/N) \quad (3.2)$$

Root Mean Square Error (RMSE) is calculated, as shown in Table 3.1, comparing the RMSE between the simulated and real values of the four drivers, $RMSE_{\text{Number of tourists}}$ <$RMSE_{\text{Passenger Transportation on Roads and Railroads}}$ <$RMSE_{\text{Total Retail Sales of Consumer Goods}}$ <$RMSE_{\text{Tertiary Sector Contribution Rate}}$.

Table 3.1 Comparison of Root Mean Square Errors by Driver

driving force	RMSE
Tertiary sector contribution	5.246
number of visitors	2.104
Total retail sales of consumer goods	3.860
Passenger traffic by road and rail	2.121

Combining the root-mean-square errors and fitting curves of the four drivers, it can be seen that the number of tourists has the greatest strength of driving force for Xinjiang's regional airport aviation network connection, followed by the volume of road and rail passenger traffic, followed by total retail sales of consumer goods, while the tertiary industry contribution rate has a large fitting error. This suggests that the tertiary industry contribution rate in Xinjiang is not the core driver among the drivers of aviation network connectivity of Xinjiang's feeder airports, probably because the tertiary industry contribution rate does not directly represent the effective demand, whereas the number of tourists, the volume of passenger transportation by road and rail, and the total retail sales of consumer goods have a relatively greater impact on the air route connectivity between the two cities.

4 Conclusion

Using the input-output model to analyze the 2017 input-output table of Xinjiang and the whole country shows that: consistent with the correlation characteristics of the air transportation industry and the tertiary industry at the national level, the air transportation industry in Xinjiang consumes the most of the secondary industry, and the tertiary industry in Xinjiang has the most demand for air transportation. From the perspective of air transportation demand, based on the integration and development characteristics of Xinjiang's air transportation industry with other service industries in the tertiary industry, we construct the driving path of industrial integration to promote air network connectivity.

Constructing the indicator system of driving factors of air network connection considering transportation demand, using gray correlation analysis to calculate the correlation degree between air transportation indicators and indicators of tertiary industry, analyzing that the integration of air transportation and tertiary industry is at the stage of friction, and screening out the main driving factors of air network connection, including: the number of tourists, the contribution rate of the tertiary industry, the volume of passenger traffic of roads and railroads, and total retail sales of social consumer goods. Total retail sales.

Based on the priority connection model, the simulation network is constructed by considering the priority connection of each major driving factor, and compared with the real network, the number of tourists, the passenger traffic volume of roads and railroads, and the total retail sales of consumer goods have a greater driving force for the connection of the aviation network, and the tertiary industry contributes a relatively small power effect. Combined with the industrial structure and geographic characteristics of Xinjiang, the demand for air transportation needs to have the needs of economic and social activities, as well as multimodal transportation with other modes of transportation, in order to form an effective demand for air transportation.

References

[1] Liu Hongkun, Zhang Xiaoli, Cao Used et al. Analysis of route connection mechanism

of Chinese urban aviation network[J]. Science in China (Series G: Physics Mechanics Astronomy), 2009, 39(07):935-942.

[2] Han Hong. The impact of national economy and its industrial sectors on civil aviation transportation industry[J]. Open Herald, 2009,(04):106-110.DOI:10.19625/j.cnki.cn44-1338/f.2009.04.023

[3] Zeng Xiaozhou, Jiang Keshen, Dong Lili. Analysis of the driving force of China's aviation network route connectivity based on gravity model[J]. Journal of Harbin University of Commerce (Natural Science Edition), 2012, 28(2):251-256.

[4] Chi J, Baek J. Dynamic relationship between air transportation demand and economic growth in the United States : a new look [J].TransportPolicy, 2013, 29. 257-260.

[5] Maparu T S, Mazumder T N. Transport infrastructure, economic development and urbanization in India (1990-2011):is there any causal relationship ? [J].Transportation research part A:policy and practice, 2017, 100:319-336.

[6] Feng Yu, Ge Torch. Analysis of driving force of Xinjiang regional aviation network connection based on gray correlation clustering model[J]. Logistics Science and Technology, 2019, 42(08):113-116.DOI:10.13714/j.cnki.1002-3100.2019.08.029

[7] Li Yanwei, Luo Yang. Research on the connectivity driving mechanism of China's transportation airport route network based on fsQCA[J]. Practice and understanding of mathematics, 2020, 50(18):84-94.

[8] Zhang Guoqiang. High-quality development drives faster growth in air transportation demand[J]. Comprehensive Transportation, 2023, 45(07):1

[9] Zhang Huimeng. Analysis of agricultural linkages and ripple effects based on input-output modeling[J]. Rural Economy and Science and Technology, 2024, 35(14):22-24.

[10] plug heming. Analysis of Influencing Factors of Agricultural Product Logistics in China Based on Gray Correlation[J]. Hebei Enterprise, 2018,(12):107-109.

[11] YANG Fang, ZHANG Ziyao, HUANG Qianqian, et al. Analysis of Influencing Factors of Agricultural Products Logistics and Transportation in Gansu Province-Based on Gray Correlation and Cluster Analysis[J]. Logistics Science and Technology, 2024, 47(13):66-70.DOI:10.13714/j.cnki.1002-3100.2024.13.018.