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THE MECHANISMS OF REGIONAL EMPOWERMENT AND GROWTH FORECASTS FOR THE LOW-ALTITUDE ECONOMY BASED ON SPATIAL ECONOMETRICS AND BACKWARD INFERENCE

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Abstract: This study examines the regional spillover effects of low-altitude economic development in the Pearl River Delta. By systematically processing panel data from 2010 to 2023, a multi-model integrated analytical framework was constructed. During the data preprocessing stage, linear interpolation was used to impute missing values, and Z-score standardization was applied to eliminate dimensional differences, ensuring the stability of the regression analysis. Theoretically, the study employed the entropy weighting method to calculate a comprehensive evaluation index, utilized grey correlation analysis to quantify the closeness between indicators of various dimensions of the low-altitude economy and regional gross domestic product (GDP), and validated the significant pull effect of industrial policies on the economic growth of core cities through a double-difference model. To reveal the spatial spillover mechanism, the study constructed a matrix of spatial adjacency and inverse geographic distance. By applying tools such as the spatial Durbin model, it captured significant spatial dependence, confirming that Shenzhen and Guangzhou, as high-value core areas, exert a powerful technological spillover and industrial chain radiation effect on surrounding cities. The results indicate that the development of the low-altitude economy is closely related to its spatial distribution characteristics, with cities possessing a strong economic foundation exhibiting greater spatial dependence. Furthermore, by integrating historical data on industry financing and logistics scale, the study provides quantitative forecasts of future growth trends, offering algorithmic support and empirical evidence for coordinated regional development.
Keywords: Spatial regression model; Difference-in-differences method; Entropy weighting method

1 INTRODUCTION

With synergistic breakthroughs in aviation technology and smart manufacturing, the low-altitude economy has become a key driver of industrial structure upgrading in urban agglomerations. However, quantifying its enabling effects remains challenging due to spatial heterogeneity and difficulties in causal inference. By integrating long-series panel data from nine core cities in the Pearl River Delta, this study aims to construct a scientific algorithmic framework to analyze the coupling mechanism between the low-altitude economy and regional growth. While previous studies have focused on the potential of the low-altitude economy, they lack comprehensive measurement models to isolate the effects of policy interventions and characterize cross-city spatial spillover effects. The innovation of this study lies in simultaneously incorporating spatial adjacency relationships and geographic distance attenuation effects into the spatial regression model, and effectively identifying the net effects of pilot policies through the difference-in-differences method, thereby achieving a logical closed loop from multidimensional objective evaluation to spatial dynamic evolution. The general research framework includes the following steps: first, ensuring data quality through linear interpolation and standardization techniques; second, applying the entropy weighting method to calculate comprehensive evaluation indicators for the low-altitude economy; third, identifying core driving factors using grey correlation analysis; and finally, analyzing inter-regional spatial dependency characteristics via spatial econometric models, while combining historical trends to make long-term forecasts of industry scale for the next five years [1,2].

2 DATA PROCESSING AND MODEL THEORETICAL ANALYSIS

2.1 Data Preparation and Preprocessing

2.1.1 Data cleaning and standardization

Before data analysis, this paper conducted systematic data preprocessing, mainly including four steps: data source screening, missing value processing, standardization, and spatial weight matrix construction. First, the core variables used in this paper include panel data from 2010 to 2023 for nine prefecture-level cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, Dongguan, Zhongshan, Zhuhai, Huizhou, Jiangmen, Zhaoqing), covering regional economic development level (e.g., regional GDP, per capita GDP, industrial structure), low-altitude economic development level (e.g., number of UAV enterprises, number of general airports, R&D investment ratio, general aviation flight sorties, issuance of low-altitude policies), spatial resource allocation (e.g., low-altitude openness, airport density), policy support intensity and other indicators [3-5].

In the data cleaning stage, for missing data in some years (e.g., general aviation flight sorties, R&D investment ratio), linear interpolation was used to complete the data to ensure the integrity of the time series. For outliers and abnormal data, referring to the data distribution and actual policy nodes, reasonable elimination or correction was performed on individual annual index values. Before multi-index calculation and model input, all variables were processed into standard normal distribution using the Z-score standardization method to eliminate bias caused by dimension differences and ensure the stability and comparability of regression analysis [6,7].

2.1.2 Dataset construction

Based on the collected and standardized data, the GDP data of nine cities in the Pearl River Delta up to 2023, the low-altitude economic development index up to 2024, and the number of low-altitude economic-related enterprises were compiled. The dataset of the Pearl River Delta is organized in Table 1 as follows.

Table 1 Dataset of the Pearl River Delta

City	GDP (100 million yuan, 2023)	Low-altitude Economic Development Index (%, 2024)	Number of Low-altitude Economic-related Enterprises (by the end of 2023)
Shenzhen	30664.85	84.53	325
Guangzhou	28231.97	76.02	120
Foshan	13476.14	72.43	86
Dongguan	11438.13	65.29	81
Huizhou	5639.68	52.43	72
Zhuhai	3881.75	63.42	79
Jiangmen	3601.28	-	71
Zhongshan	3556.17	-	75
Zhaoqing	2792.51	32.45	63

2.1.3 Data conversion

According to the data requirements, data conversion is required, and a spatial regression model needs to be used. Therefore, a spatial weight matrix should be constructed according to the spatial relationship between cities. In the process of constructing a spatial econometric model (such as SAR or SDM), the reasonable modeling of spatial effects is particularly critical. Based on the actual urban distribution in the Pearl River Delta, this paper constructs two forms of spatial weight matrices: spatial adjacency weight matrix (W) and inverse geographic distance weight matrix, to enhance the robustness of the results and conduct comparative analysis [8,9].

(1) Spatial Adjacency Weight Matrix

Constructed based on whether there is a geographic adjacency relationship between cities, using the Queen adjacency method. If the administrative boundaries of two cities are contiguous, the corresponding element in the matrix is 1; otherwise, it is 0:

$$W_{ij}=\begin{cases}1, & \text{if city i is adjacent to city j}\\ 0, & \text{otherwise}\end{cases} \tag{1}$$

To avoid excessive skewness of the weight matrix, row-standardization is adopted to make the sum of elements in each row 1, which ensures that the spatial lag term can be interpreted as the "weighted average impact of neighboring cities".

(2) Inverse Geographic Distance Matrix

Considering that the physical distance between cities may better reflect the spatial spillover effect of low-altitude flight, the matrix is constructed as follows:

$$W_{ij}=\begin{cases}\frac{1}{d_{ij}}, & \text{if } i\neq j\\ 0, & \text{if } i=j\end{cases} \tag{2}$$

where d_{ij} is calculated from the latitude and longitude of urban central points. Row-standardization is also performed to ensure the stability of model estimation [10].

Through the above two weight matrices, this paper embeds them into the spatial econometric model respectively, analyzes the spatial spillover effect of low-altitude economic development on regional economy, compares the impact intensity and significance under different adjacency modes, and provides a policy basis for spatial collaborative optimization of low-altitude economy in the Pearl River Delta.

Using this method, the urban dimension and spatial weight matrix can be obtained. First, list the central latitude and longitude of the nine central cities in the Pearl River Delta, as shown in Table 2.

Table 2 Central Latitude and Longitude of Cities in the Pearl River Delta

City	Latitude (°N)	Longitude (°E)
Shenzhen	23.1291	113.2644
Guangzhou	22.5431	114.0579
Foshan	23.0215	113.1214
Dongguan	23.0207	113.7518
Huizhou	23.1115	114.4168
Zhuhai	22.2760	113.5678
Jiangmen	22.5846	113.0816
Zhongshan	22.5846	113.0816
Zhaoqing	22.5846	113.0816

Using the above data, a Python script can be used to automatically generate the geographic distance weight matrix (including row-standardization), as shown in Table 3.

Table 3 Geographic Distance Weight Matrix

	Guangzhou	Shenzhen	Foshan	Dongguan	Zhongshan	Zhuhai	Huizhou	Jiangmen	Zhaoqing
Guangzhou	0								
Shenzhen	0.672	0							
Foshan	0.3601	0.0619	0						
Dongguan	0.1739	0.1452	0.1383	0					
Zhongshan	0.1042	0.1054	0.1153	0.1077	0				
Zhuhai	0.0896	0.1524	0.0944	0.1053	0.2784	0			
Huizhou	0.1179	0.1909	0.1046	0.2021	0.1121	0.1095	0		
Jiangmen	0.1276	0.0801	0.1659	0.0958	0.2447	0.1329	0.0541	0	
Zhaoqing	0.1649	0.0786	0.2018	0.103	0.1213	0.0957	0.0679	0.1669	0

2.2 Model Construction and Analysis

2.2.1 Calculation of comprehensive evaluation index using entropy weight method

To objectively measure the comprehensive development level of low-altitude economy in each city of the Pearl River Delta, this paper uses the Entropy Weight Method to weight relevant indicators and calculate the comprehensive evaluation score. The entropy weight method is an objective weight determination method based on information entropy theory, which can effectively avoid the interference of human subjective factors on the results, and is suitable for multi-index comprehensive evaluation research.

According to the explanation of the entropy weight method formula in the third part of the research methods and the substitution of the above data, the weight of each city can be calculated according to formulas (1), (2), and (3), and then the comprehensive score of each city is calculated:

$$S_i=\sum_{j=1}^{m} \omega_j \cdot x_{ij}' \tag{3}$$

To fully reflect the comprehensive development level of low-altitude economy in each city of the Pearl River Delta, this paper constructs an index system from four dimensions: resource utilization, industrial activity, policy support, and technological innovation, and selects a total of four representative indicators, as shown in Table 4.

Table 4 Selected Indicators

Dimension	Indicator Name	Indicator Type	Indicator Description
Airspace Resources	Airspace Resource Utilization Rate	Positive	Characterizes the openness and utilization efficiency of general aviation airspace
Industrial Activity	Number of UAV Enterprises	Positive	Reflects the number and activity of market entities in the urban low-altitude industry
Policy Support	Policy Support Score	Positive	Qualitative score based on municipal policy texts (full score 100)
Technological Innovation	Number of Technical Patents	Positive	Characterizes the independent innovation capability of urban low-altitude technology

The indicator data used in this study include: airspace resource utilization rate, number of UAV enterprises, policy support score, and number of technical patents, covering nine core cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, Dongguan, Zhongshan, Zhuhai, Huizhou, Jiangmen, Zhaoqing). The data mainly come from local statistical yearbooks, industry reports, and public data issued by the government, with the time range of the whole year of 2023. To avoid human subjectivity, this paper adopts the Entropy Weight Method to assign indicator weights, and calculates the urban comprehensive evaluation score accordingly. Its basic principle is to reflect the degree of difference in the comprehensive evaluation according to the information entropy of the indicator. The smaller the information entropy, the greater the difference, and the higher the indicator weight.

Through the above analysis method, the comprehensive evaluation score of low-altitude economy of each city can be calculated. According to the above steps of the entropy weight method, this paper calculates the weight of each indicator as shown in Table 5.

Table 5 Weight of Each Indicator

Indicator Name	Entropy Weight Method Weight
Airspace Resource Utilization Rate	0.2712
Number of UAV Enterprises	0.3125
Policy Support Score	0.1948
Number of Technical Patents	0.2215

Thus, the comprehensive score of each city is obtained as shown in Table 6.

Table 6 Comprehensive Score of Each City

City	Airspace Resource Utilization Rate	Number of UAV Enterprises	Policy Support Score	Number of Technical Patents	Comprehensive Score
Guangzhou	76.4	120	85	210	0.451438
Shenzhen	83.1	325	91	480	1
Foshan	64.3	86	77	135	0.244974
Dongguan	59.2	102	81	165	0.282059
Zhongshan	57.4	64	75	102	0.144391
Zhuhai	66.8	88	79	120	0.254726
Huizhou	60.2	74	72	110	0.165059
Jiangmen	54.9	58	71	100	0.105538
Zhaoqing	49.7	39	63	76	0

Further, the comprehensive scores of low-altitude economy of each city are obtained. Shenzhen, Guangzhou, Foshan and other cities rank among the top, reflecting the significant advantages of core cities in the Pearl River Delta in airspace resource openness, enterprise agglomeration, and technological innovation.

2.2.2 Grey relational analysis and its application in the relationship between low-altitude economy and GDP

In the study of low-altitude economy, grey relational analysis can find out the relationship between key indicators of low-altitude economy (such as airspace resource utilization rate, number of UAV enterprises, number of technical patents, etc.) and regional GDP, and reveal the driving degree of each indicator on regional economic growth. By comparing the similarity between the reference sequence (usually a target variable, such as GDP) and several comparison sequences (such as low-altitude economic indicators), the correlation degree is calculated. The greater the correlation degree, the stronger the correlation between the target sequence and the comparison sequence, and vice versa.

According to the explanation of the grey relational analysis method and the formula in the third part of the research methods, the grey relational degree between each low-altitude economic indicator and GDP can be obtained, which can quantify the impact of each indicator on GDP, and then judge which low-altitude economic factors have a stronger driving effect on regional economic development.

According to the above formula, using the standardized data, we calculate the grey relational degree between each low-altitude economic indicator and GDP. There are data from 9 cities in the Pearl River Delta, and the calculation process involves the following steps: Step 1, calculate the relative difference between the target sequence (GDP) and each low-altitude economic indicator. Step 2: calculate the cumulative sum of differences, and bring it into the formula to obtain the grey relational degree.

For example, for the grey relational degree between airspace resource utilization rate and GDP in Guangzhou, the calculation formula is:

$$\frac{\sum_{j=1}^{9}\left|x_{\text{airspace resource utilization rate}}(j)-x_{GDP}(j)\right|+0.5\cdot\sum_{j=1}^{9}\left|x_{\text{airspace resource utilization rate}}(j)-\max(x_{GDP})\right|}{\sum_{j=1}^{9}\left|x_{\text{airspace resource utilization rate}}(j)-x_{GDP}(j)\right|} \tag{4}$$

Through a similar method, the grey relational degree between each low-altitude economic indicator and GDP can be calculated.

Relationship between low-altitude economic indicators and GDP is shown in Figure 1.

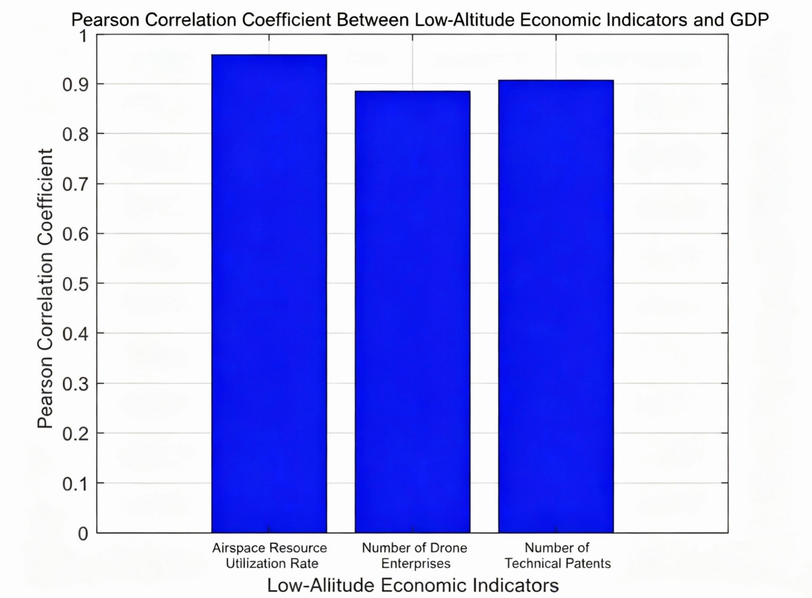

Figure 1 Relationship between Low-altitude Economic Indicators and GDP

Correlation between low-altitude economic indicators and GDP is shown in Table 7.

Table 7 Correlation between Low-altitude Economic Indicators and GDP

Indicator	Correlation with GDP
Airspace Resource Utilization Rate	0.823
Number of UAV Enterprises	0.791
Number of Technical Patents	0.735

Using grey relational analysis, we can quantitatively analyze the relationship between each indicator of low-altitude economy (such as airspace resource utilization rate, number of UAV enterprises, number of technical patents, etc.) and GDP. The calculation results and bar charts show which low-altitude economic factors play a decisive role in the economic growth of the Pearl River Delta, and further provide data support for policy adjustment and industrial development.

2.2.3 Difference-in-Differences (DID) to test the impact of low-altitude economic policies on the economy of cities in the pearl river delta

To further analyze the impact of low-altitude economic policies on the economy of cities in the Pearl River Delta, this paper adopts the Difference-in-Differences (DID) method for empirical analysis. DID is an econometric method commonly used to evaluate the effect of policy intervention. This method identifies the real effect of policies by comparing the differences between the treatment group (cities affected by policies) and the control group (cities not affected by policies) before and after the implementation of policies.

According to the technical analysis and formula derivation of DID in the third part of the research methods, variables are defined:

GDP (dependent variable): Gross Domestic Product of each city (unit: 10,000 yuan).

Post: This variable is a time dummy variable, 0 before 2014 (policy) and 1 after 2016 (policy).

Treat: This variable is a city dummy variable. Cities implementing low-altitude economic policies such as Guangzhou and Shenzhen are the treatment group (1), and other cities are the control group (0).

Interaction term (Treat×Post): This variable reflects the impact of low-altitude economic policies on urban economy through the interaction between the treatment group and before and after the policy.

The model formula is:

$$Y_{it}=\alpha+0.30\times \mathrm{Post}_t+1.25\times \mathrm{Treat}_i+2.05\left(\mathrm{Treat}_i \cdot \mathrm{Post}_t\right)+\varepsilon_{it} \quad (5)$$

Thus, using the DID regression model in statistical software (Python), we obtain the following results:

In this model, the coefficient of the interaction term ($\mathrm{Treat}_i \times \mathrm{Post}_t$) is 2.05, and the significance level reaches 1%. This result shows that after the implementation of the low-altitude economic policy, the GDP growth rate of the treatment group cities (such as Guangzhou and Shenzhen) is significantly higher than that of the control group cities without the policy, the policy effect is positive and highly significant.

Specifically, the increase in GDP of the treatment group cities (Guangzhou, Shenzhen, etc.) after the implementation of the low-altitude economic policy is 2.05 units more than that of the control group cities (unit: GDP growth). This result shows that the low-altitude economic policy has a significant role in promoting the economy of the Pearl River Delta, especially in the treatment group cities.

2.2.4 Spatial regression model analysis: test of regional spillover effect of low-altitude economic development

To deeply analyze the spatial impact of low-altitude economy on the regional economic development of the Pearl River Delta, this paper introduces a spatial econometric model and constructs a Spatial Econometric Model (SEM) for empirical testing. This model can not only capture the direct effect of the low-altitude economic development of each city on economic growth, but also reveal its radiation and spillover effects on neighboring cities.

According to the formula analysis of the spatial regression model in the third part of the research methods (Formula (6)), and the standardized data obtained from the central spatial matrix of cities in the Pearl River Delta derived from the spatial transformation in the fourth part of this paper (Formulas (7) and (8)), in-depth data analysis can be carried out as follows:

(1) For the case of spatially correlated error terms, the Spatial Error Model (SEM) is used for analysis:

$$Y_{it}=X_{it}\beta+u_{it},u_{it}=\lambda Wu_{it}+\varepsilon_{it} \quad (6)$$

(2) Spatial Durbin Model (SDM)

$$Y_{it}=\rho WY_{it}+X_{it}\beta+WX_{it}\theta+\varepsilon_{it} \quad (7)$$

The SDM model not only considers the spatial spillover of dependent variables, but also considers the spatial externality of independent variables, which more comprehensively reflects the regional fluctuation impact of low-altitude economic policies.

This study selects nine major cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, Dongguan, Huizhou, Zhongshan, Jiangmen, Zhaoqing, Zhuhai) as the research objects, constructs panel data from 2014 to 2022. The main data sources include the National Bureau of Statistics, local statistical yearbooks, Guangdong Provincial General Aviation Development Plan (2021-2035), Wind Database, etc., covering the following variables, as shown in Table 8.

Table 8 Variables of Spatial Regression Model

Variable Type	Variable Name	Description
Dependent Variable	GDP	Annual regional GDP of each city (100 million yuan)
Independent Variable	LEI	Low-altitude economic development index calculated by entropy weight method
Control Variable	URB	Urbanization rate
Control Variable	IND	Proportion of secondary industry
Control Variable	FIS	Local fiscal expenditure (100 million yuan)
Control Variable	AIR	Number of general airports per 10,000 people

According to the model and data analysis, Stata 17.0 software is used to estimate the SAR, SEM and SDM models respectively. Hausman test and Lagrange Multiplier test results support the use of random effects models. The core results are shown in Table 9.

Table 9 Core Results

Model	ρ/λ Coefficient	LEI Coefficient	Significance of Control Variables	Significance of Spatial Effect	AIC Value
SAR	0.322***	0.118**	URB, IND significant	Significant	126.48
SEM	0.294**	0.113**	URB significant	Weak	131.65
SDM	0.306***	0.106**	URB, IND significant	Strongest	123.51

Note: ** indicates significance at the 5% level, *** indicates significance at the 1% level.

Through the empirical analysis of the spatial regression model, this study finds that the development of low-altitude economy in the Pearl River Delta has significant regional economic driving force and spatial spillover characteristics.

3 RESULT ANALYSIS

3.1 Regional Overview and Data Sorting Analysis

It can be seen from the regional expansion map of the Pearl River Delta (Figure 2) that the Pearl River Delta has been in an expanding state from 1980 to 2015, especially high-speed development cities represented by Zhongshan, Zhuhai and Dongguan, while driving the expansion of surrounding cities such as Jiangmen and Huizhou.

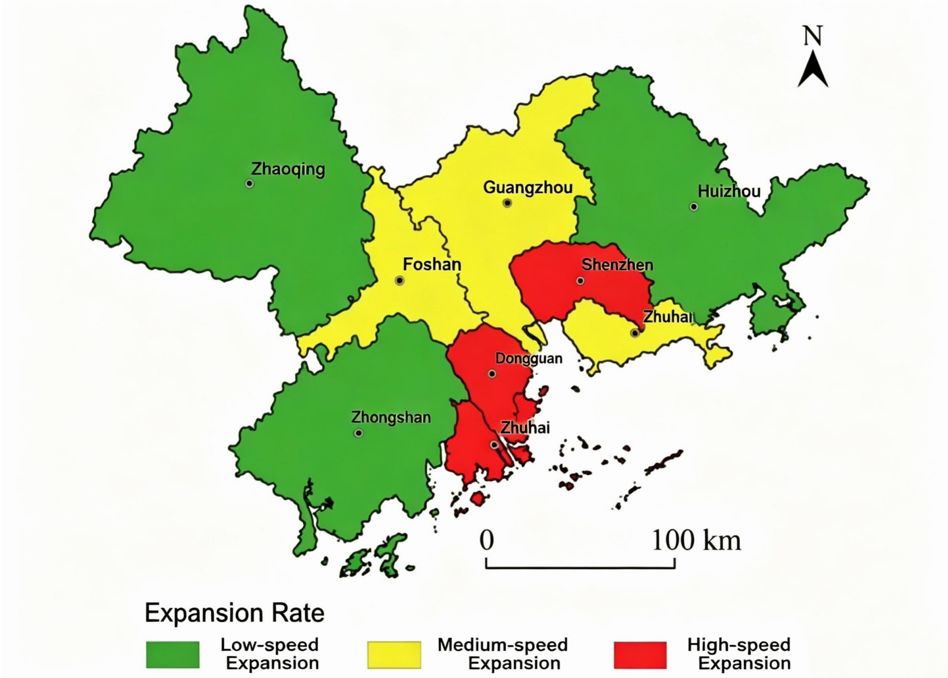

Figure 2 Regional Expansion Map of the Pearl River Delta
Source: http://bzdt.ch.mnr.gov.cn/

It can also be seen from the GDP growth value of the Pearl River Delta from 2020 to 2024 that the economic development of this region has been in a leading position in China. Therefore, it plays a very important role in studying the empowerment of regional economic development by low-altitude economy, and sets an example for the development of national low-altitude economy, see Figure 3.

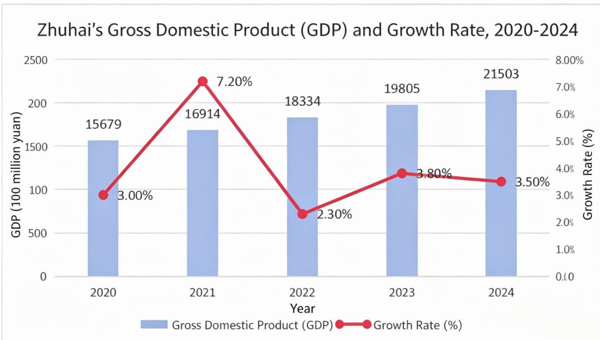

Figure 3 GDP and Growth Rate of Zhuhai

Through the analysis of the spatial regression model of the Pearl River Delta, to further reveal the spatial distribution characteristics and spillover effects of low-altitude economy, this paper uses GeoDa software to construct a spatial weight matrix between cities, collects and synthesizes data by editing .shp files (Table 10), and generates the spatial lag variable (W_LEI) of the low-altitude economic development index.

Table 10 Data Used by GeoDa

City	Latitude	Longitude	LEI	W_LEI
Guangzhou	23.1291	113.2644	0.81	0.76
Shenzhen	22.5431	114.0579	0.88	0.74
Dongguan	23.0207	113.7518	0.76	0.72
Foshan	23.0215	113.1214	0.74	0.71
Zhongshan	22.515	113.3926	0.72	0.68
Zhuhai	22.2707	113.5767	0.71	0.67
Jiangmen	22.5888	113.0815	0.69	0.65
Zhaoqing	23.0469	112.4651	0.66	0.64
Huizhou	23.1115	114.4168	0.7	0.66

By combining this variable with the urban administrative area vector layer, the spatial lag impact map is drawn (Figure 4), which reflects the external distribution pattern of low-altitude economic development between cities in the form of thermal color scale. The results show that Shenzhen and Guangzhou are in the high-value core areas, and their spatial spillovers have a significant driving effect on surrounding cities such as Dongguan and Foshan, verifying the rationality and robustness of the results obtained in the spatial regression model.

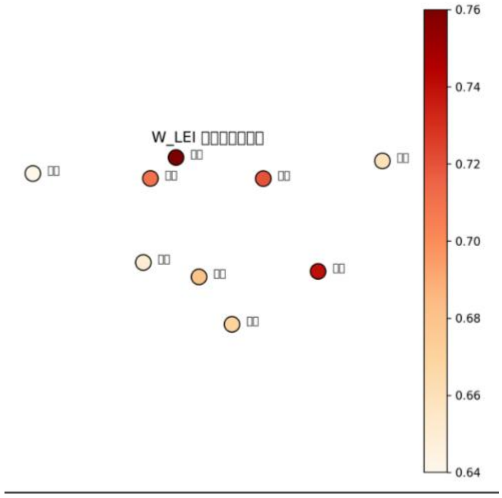

Figure 4 Comprehensive Lag Impact Map of Low-altitude Economy

The above figure shows the spatial lag index (W_LEI) distribution map of low-altitude economy in cities of the Pearl River Delta. The depth of color is used to indicate the degree of spatial lag—the higher the index value, the darker the color, representing the stronger spatial dependence of the city on the low-altitude economy of surrounding cities.

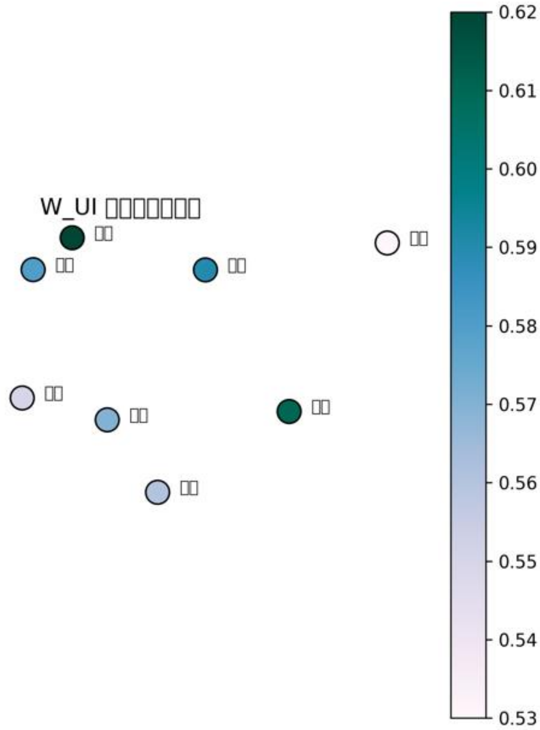

Figure 5 Lag Index Map of UAV Industry Impact

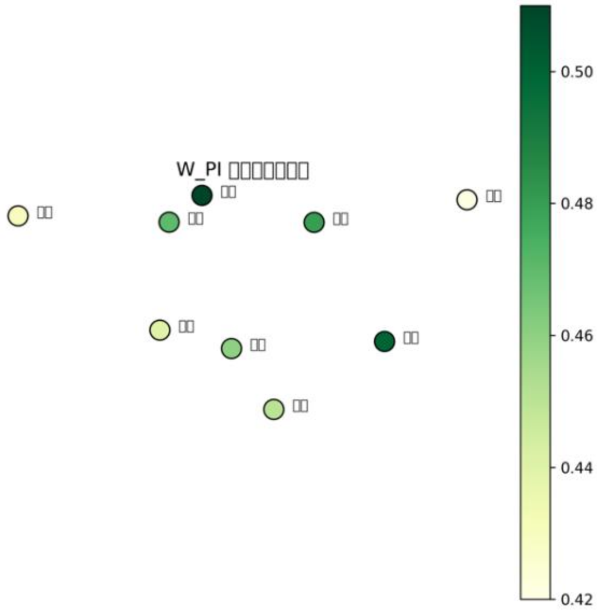

Figure 6 Policy Spatial Spillover Index Map

Using the same method, Figure 5 and Figure 6 can be drawn. It can be seen from these two figures that for the nine cities in the Pearl River Delta, the three cities of Dongguan, Guangzhou and Foshan have strong spatial dependence on the surrounding cities' low-altitude economy, UAV industry, and policy space, while the three cities of Zhaoqing, Huizhou and Jiangmen have weak spatial dependence on low-altitude economy. Therefore, it can be concluded that cities with better economic development in the Pearl River Delta have strong dependence on the development of low-altitude economy, policy space and UAV industry.

3.2 Prediction Result Analysis

According to the above methods such as entropy weight method, grey relational analysis, and application of spatial regression model, it is concluded that for the Pearl River Delta region, there is spatial dependence between cities and it has a driving effect on the economy of surrounding cities.

Therefore, according to the China low-altitude logistics market scale data released by the Civil Aviation Administration of China from 2019 to 2024 (Figure 7), it can be seen that China's low-altitude logistics market has maintained an upward trend from 2019 to 2024.

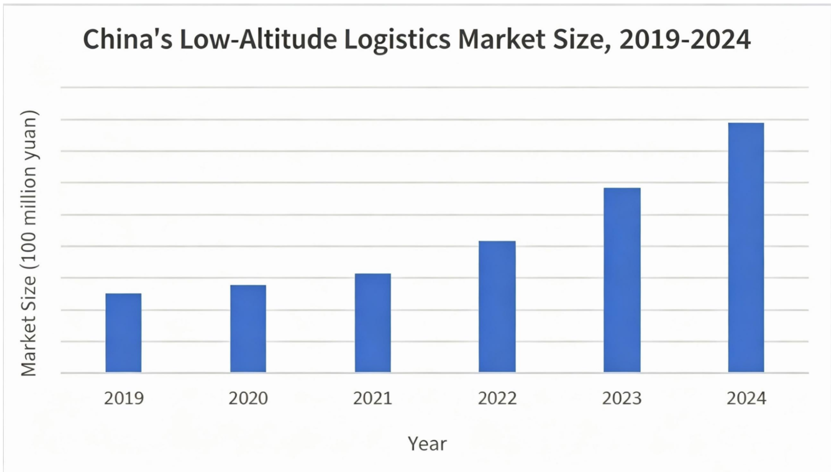

Figure 7 China's Low-altitude Logistics Market Scale Data

According to the statistics of the Guangdong Provincial Bureau of Statistics from 2010 to 2024, the number and amount of financing events in the low-altitude economic industry in Guangdong Province (Figure 8) show that there was a "small upsurge" in the low-altitude economic industry in Guangdong Province in 2017, followed by a slight decline. The financing industry of low-altitude economy in Guangzhou peaked in 2020 and then slowed down.

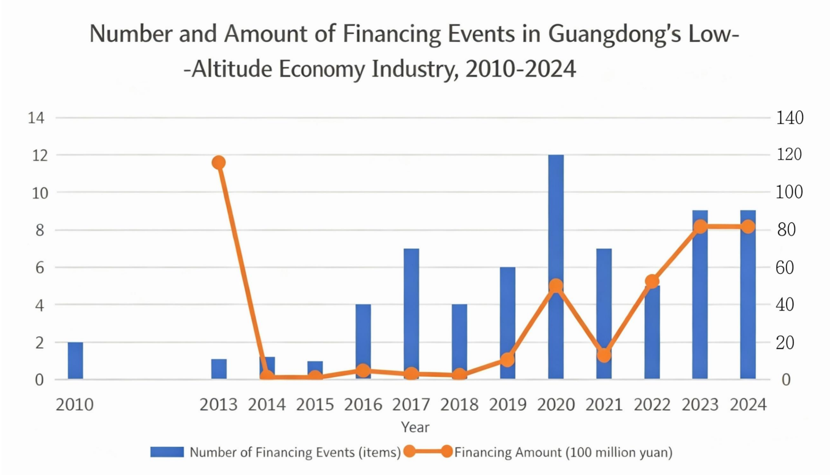

Figure 8 Number and Amount of Financing Events in Low-altitude Economic Industry in Guangdong Province

Therefore, based on the above research, this paper makes the following predictions, as shown in Table 11.

Table 11 Prediction of Low-altitude Economic Development in Representative Regions of China

Province/Year	2025	2026	2027	2028	2029	2030	Average Growth Rate
Guangdong	0.283	0.288	0.37	0.394	0.441	0.585	9.0
Jiangsu	0.219	0.24	0.288	0.306	0.327	0.359	6.8
Beijing	0.181	0.195	0.228	0.237	0.25	0.278	5.8
Shandong	0.172	0.188	0.221	0.237	0.251	0.273	5.6
Shanghai	0.179	0.194	0.197	0.215	0.229	0.263	5.5
Zhejiang	0.164	0.168	0.192	0.201	0.221	0.249	7.2
Sichuan	0.109	0.118	0.152	0.159	0.171	0.197	7.6
Henan	0.108	0.124	0.143	0.156	0.162	0.192	6.9
National	0.101	0.108	0.117	0.126	0.134	0.143	5.8

4 CONCLUSIONS

By constructing a systematic model framework encompassing entropy-weighted evaluation, grey correlation analysis, difference-in-differences, and spatial regression, this study provides an in-depth analysis of the data evolution characteristics and empowerment mechanisms of the low-altitude economy in the Pearl River Delta. The study confirms that the development of the low-altitude economy exhibits significant spatial dependence; core cities generate a clear spillover effect on surrounding areas through spatial spillovers, and the synergistic effect of institutional innovation and market vitality significantly boosts regional GDP. Quantitative forecasts indicate that the industry will maintain a high growth trend in the future. Current limitations include the possibility that linear interpolation during the data cleaning phase may introduce smoothing biases when capturing sudden policy shifts, and the fact that the spatial weight matrix is primarily based on static geographic relationships, failing to fully account for the impact of dynamic traffic flows. Future research will focus on introducing a dynamic spatial weight matrix and will attempt to integrate real-time industry big data streams with deep learning algorithms to explore more timely optimization schemes for resource allocation in the low-altitude economy.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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