WEP Warwick Evans Publishing

International Journal of Global Economics and Management

ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 7, Number 2, Year 2025
DOI: https://doi.org/10.62051/ijgem.v7n2.03
Journal homepage: https://ijgem.org

Research on the Regional Development Index of China's Low-altitude Economy Based on the Entropy Weight Method

Wenbo Chang *

China Auto Information Technology (Tianjin) Co., Ltd., Tianjin, China
*Corresponding Author: 17612272430@163.com

ABSTRACT

At present, the low-altitude economy, as a strategic emerging industry, serves as a pivotal driver of economic growth, technological innovation, and social service enhancement. In order to better assess the development of the low-altitude economy in different regions of China, this paper proposes a low-altitude economic development index based on the entropy weight method. First, following the principles of scientificity, systematicness and practicality, a 3X3 pyramid-shaped evaluation system is constructed; Then, the data will be preprocessed using the box plot method and the supplementary method; Finally, the entropy weight method was used to calculate the results of the low-altitude economic development index for different regions. The results showed that provinces in the eastern coastal region scored high, while those in the central and western regions lagged behind. The method can provide more targeted advice for policy-making and industrial development.

KEYWORDS

Low-Altitude Economy; Entropy Weight Method; Boxplot; Data Preprocessing; Development Index

1. RESEARCH BACKGROUND

Against the backdrop of rapid global economic and technological development, the low-altitude economy, a strategic emerging industry, is emerging as a new force [1] driving economic growth, technological innovation and upgrading of social services. It is centered on the low-altitude flight activities of civil aircraft, driving the coordinated development of the entire industrial chain including R&D and manufacturing, infrastructure, and derivative services, and forming a new economic form [2] of integration and innovation. The industrial chain of the low-altitude economy is long and covers a wide range of areas, from upstream aircraft research and manufacturing to midstream flight operation services and downstream application scenario expansion, with each link containing huge development potential. It is expected that the industrial scale of the domestic low-altitude economy will reach more than 6 trillion yuan [3] by 2035.

There are many academic achievements in the study of regional development indices. The results are mostly focused on the general assessment of regional competitiveness, covering economic, social and environmental aspects [4-6]. For example, the literature [4] has studied the evaluation of regional green and low-carbon development index under the dual control of carbon emissions. Based on the dual control of carbon emissions, this paper summarizes practical methods and constructs a standardized evaluation system by implementing the collection of regional development data, organizing green and low-carbon indicators, determining the weight distribution of indicators, and integrating the evaluation patterns of the index, with the aim of facilitating the innovative development of related industries in terms of green development goals, development needs, and green development trends. In order to enhance the economic benefits of our regions and make them sustainable. In order to [5] fully study the relationship between the development index of modernization of vocational education in China and regional development, an evaluation index system for the development of modernization of vocational education in China was constructed, and the entropy weight TOPSIS method was used for measurement analysis and regional comparison. By optimizing the overall coordination mechanism for the input of vocational education resources, designing a differentiated development model for the opening up of vocational education to the outside world, building a cross-provincial collaborative governance system for the development of vocational education, and promoting the coordinated development of vocational education and regional economic and social development, the level of modernization of vocational education in China has been improved. The "2024 China Urban Low-altitude Economic Development Index Report" released by 36Kr Research Institute evaluated key cities across the country involved in the low-altitude economic industry and ranked the urban low-altitude economic development index, providing a certain reference for the development of the urban low-altitude economy.

Although there is a certain foundation for the study of regional development indices, there are still some deficiencies in these studies at present, such as the need to further improve the scientificity and completeness of the index system, and the need to further verify the rationality and objectivity of the method of assigning weights to the indicators. Based on these factors, this paper proposes the "Regional Development Index of China's Low-altitude Economy based on Entropy Weight Method", aiming to establish a dynamic evaluation system, scientifically assess regional development levels through multi-dimensional indicators, provide data support for relevant departments to analyze regional differences, accurately identify strengths and weaknesses, and accelerate the formation of a new paradigm for high-quality development of the low-altitude economy.

2. RESEARCH ROUTE

The research route of this paper consists of five parts: selection of the evaluation indicator system, data preprocessing, entropy weight method assignment, comprehensive score calculation, and results and analysis. The research roadmap of this paper is shown in Figure 1.

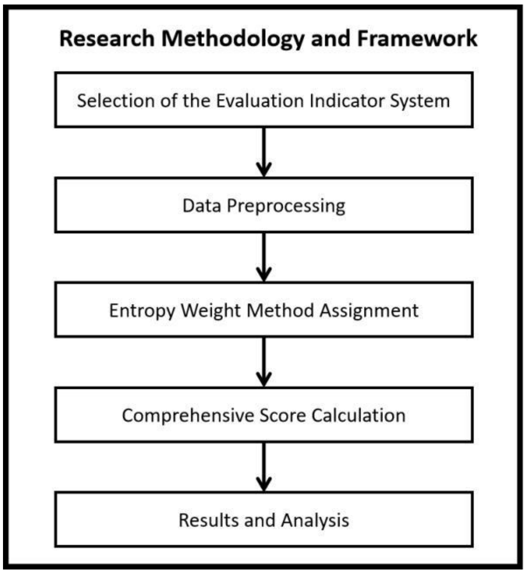

Figure 1. The research roadmap of this paper

2.1. Selection of the Evaluation Index System

2.1.1. Criteria selection principles

When constructing the low-altitude economic regional development index system, the core indicators should be strictly screened in accordance with the principles of scientificity, systematicness and practicality. Through multi-dimensional data fusion and dynamic weight allocation, ensure that the indicators are both hierarchical, dynamic adaptive and quantifiable, and ensure that the index can comprehensively, accurately and objectively reflect the actual situation of low-altitude economic regional development. To provide a reliable basis [6-7] for policy-making and development planning.

Literature research and expert consultation were employed in the selection of indicators. By extensively reviewing relevant domestic and foreign literature and consulting experts in the low-altitude field, we gained an in-depth understanding of the connotation, extension, development model and influencing factors of the low-altitude economy, and sorted out various indicators closely related to the regional development of the low-altitude economy [6-7].

2.1.2. Selection of specific indicators

(1) Policy empowerment effectiveness indicators

The empowerment effect of policies is an important factor influencing the regional development of low-altitude economies. It reflects the guiding, supporting and guaranteeing role of policies in the development of regional low-altitude economies. This paper assesses the effectiveness of policy empowerment through indicators such as the number of policies introduced, the intensity of policy support, and the effectiveness of policy implementation.

The number of policies introduced to some extent reflects the government's emphasis on the development of the low-altitude economy and the direction of policy guidance. In recent years, with the rapid development of the low-altitude economy, the national and local governments have issued a series of policy documents to support the development of the low-altitude economy. The increase in the number of policies issued indicates that the government is paying more and more attention to the development of the low-altitude economy and the guiding role of policies is growing.

The extent of policy support reflects the government's support for the development of the low-altitude economy in terms of funds, taxes, land, etc. Greater policy support can attract more enterprises and capital into the low-altitude economy sector, stimulate the enthusiasm and innovation of market entities, and promote the rapid development of the low-altitude economy.

The implementation effect of policies is a key indicator of the effectiveness of policy empowerment. Only when policies are effectively implemented can they truly contribute to the development of the low-altitude economy. If the policy goals can be achieved as scheduled, it indicates that the implementation of the policy has achieved good results and the policy's empowering effect has been effectively exerted.

(2) Indicators of technological innovation vitality

Technological innovation vitality is one of the key indicators for measuring the development of low-altitude economic regions. To systematically and efficiently assess the regional development index, this paper constructs an evaluation system covering multiple dimensions such as the proportion of research funds, the number of patent applications, and industry-university-research collaboration. Among them, research investment indicates the innovation resource base of the region, the number of patents reflects the efficiency of technology transformation, and industry-university-research cooperation reflects the level of collaborative innovation. The three together constitute the key indicator dimensions of technological innovation vitality in the regional low-altitude economy.

(3) Market development potential indicators

Market development potential is an important dimension for assessing the development of low-altitude economic regions. It reflects the development space and growth potential of the region in the low-altitude economic market. In this study, the market development potential of a region is measured by indicators such as the size of listed companies, corporate revenue, and the number of new technology scenarios applied.

2.1.3. Review of the evaluation index system

Based on the research results in the previous section, this section forms 3x3 evaluation indicators for the development of low-altitude economic regions, as shown in Figure 2.

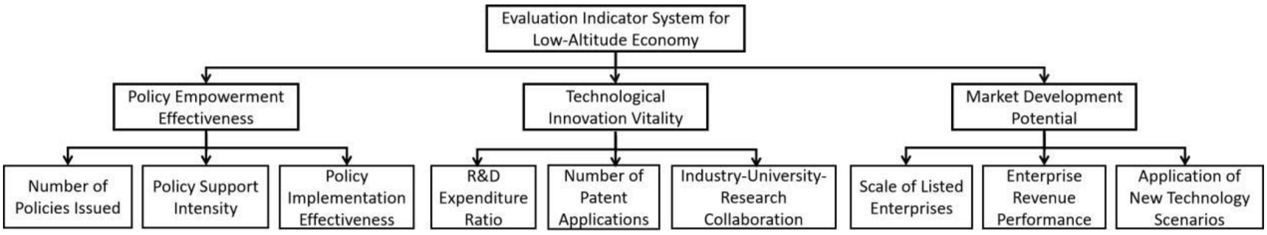

Figure 2. Evaluation indicators for the development of low-altitude economic regions

2.2. Data Preprocessing

Data preprocessing is the core step in this paper, which transforms data into a data system with uniform dimensions and format. The data preprocessing in this paper involves handling outliers and missing values.

2.2.1. Outlier detection and processing

Outliers are discrete points in a data sample that are significantly different from the distribution of the main data, and their causes have multi-source characteristics: Outliers may originate from the inherent laws of the data generation system (such as the tail extremum of the natural distribution), or from technical factors such as information collection equipment failure, human entry error, data transmission and storage error, and may not rule out the possibility that they themselves are the true reflection of objectively existing special cases or emergencies at the data level.

(1) Methods for outlier detection

For the data in this paper, the box plot method is adopted to detect outliers [7]. The formula for locating outliers is shown in Formula (1) as follows. The meaning of the formula parameters of the interquartile range method is shown in Table 1.

Table 1. Meaning of Parameters in the Quaternion Distance Method Formula

Parameters	Meaning
Z	A collection of outliers
Z_{up}	Upper outliers
Z_{low}	Lower outliers
Q_1	Represents the lower quartile, that is, all samples arranged from large to small, at the 75% position
Q_3	Indicates the upper quartile, that is, all samples arranged from large to small, at the 25% position
IQR	The calculation formula is: $Q_3 - Q_1$

$$Z = [Z_{low} \cup Z_{up}], Z_{low} < Q_1 - 1.5 \times IQR, Z_{up} > Q_3 + 1.5 \times IQR \tag{1}$$

(2) Methods for handling outliers

The method for handling outliers in this paper is as follows: A data correction strategy combining outlier elimination and missing value substitution: by using statistical diagnostic methods to identify and remove outlier observation points that significantly deviate from the distribution of the data body and incorporate them into the missing value processing flow.

2.2.2. Detection and processing of Missing value processing

(1) Detection of missing value data

This paper constructs a multi-dimensional data quality assessment framework. Firstly, it uses statistical analysis and panoramic data scanning technology to systematically diagnose the distribution pattern of null values in the data set.

(2) Processing of missing value data

First: The deletion method, directly delete data records that contain missing fields (row deletion) or feature variables with a high deletion rate (column deletion) to optimize the data matrix. This method is based on the assumption of data integrity and is suitable for features or samples with an extremely high proportion of missing items (such as over 80%). Direct deletion can significantly reduce data dimension redundancy and avoid interference [7] from low information density variables in statistical modeling.

Second: interpolation, that is, filling the missing values with the mean or median of the features. This method is used for numerical data, data sets where the feature distribution is not significantly skewed. The mean filling calculation formula is as shown in Formula (2).

$$x_f = \frac{\sum_{i=1}^{n} x_i}{n} \tag{2}$$

2.3. Entropy Weight Method Weighting

Entropy weight method is an objective method for calculating weights, which solves the problems of poor accuracy and unreliability of some subjective methods such as expert weighting, and thus has higher credibility and accuracy. The calculation process of entropy value method includes four steps: normalizing feature data, calculating the proportion of feature data, calculating the information entropy of feature data, and calculating weights. The calculation process of the entropy method is shown in Figure 3.

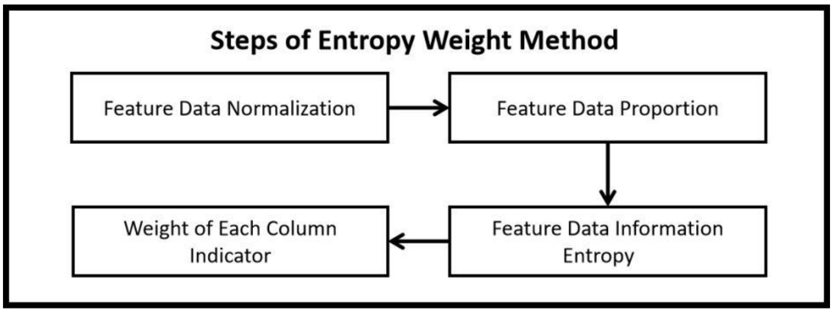

Figure 3. Entropy method calculation process

(1) Feature data normalization

Data normalization is one of the key steps in data preprocessing, which aims to transform feature data of different ranges and dimensions into numerical values at a uniform scale, eliminating dimensional differences and numerical levels between variables, and making it easier for the model to learn the patterns in the data.

The principle of data normalization: Scale the data to a specified range to eliminate the influence of dimensions. It can be used for datasets with a relatively uniform distribution of values and no obvious outliers. Maximum-minimum normalization [6-7] calculation formula such as Formula (3)

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)} \times (n\_\max - n\_\min) + n\_\min \tag{3}$$

Among them, is the normalized data, is the maximum value of the original data, is the minimum value of the original data, is the maximum value of the normalized data, is the minimum value of the normalized data. x' $\max(x)$ $\min(x)$ $n\_\max$ $n\_\min$

(2) Calculate the proportion of feature data as shown in Formula (4) below: $p_{i,j}$

$$p_{i,j} = \frac{x'}{\sum_{i=1}^{m} x'} \tag{4}$$

(3) Calculate the information entropy:

The entropy value calculation of the feature is shown in Formula (5) as follows:

$$E_j = -\frac{1}{\ln(m)} * \sum_{i=1}^{m} p_{i,j} * \ln p_{i,j} \tag{5}$$

Calculate the weights for each column of metrics as shown in Formula (6):

$$W_j = \frac{1 - E_j}{\sum_{j=1}^{n} (1 - E_j)} \tag{6}$$

2.4. Comprehensive Score Calculation

After preprocessing the data for each metric and calculating the weights, calculate the mean of each characteristic metric for all samples as shown in Formula (7):

$$\overline{x}_j = \frac{\sum_{i=1}^{m} x_{i,j}}{m} \tag{7}$$

Calculate the scores for each metric as shown in Formula (8):

$$s = \sum_{j=1}^{n} w_j \bar{x}_j \qquad (8)$$

According to the calculation formula of the entropy weight method, the score of the corresponding indicator can be S by successive substitutions.

2.5. Results and Analysis

In this paper, 10 regions were selected, namely Beijing, Jiangsu, Zhejiang, Sichuan, Guangdong, Liaoning, Jilin, Hubei, Shanxi and Shandong. The national low-altitude economic development index assessment data system was constructed after data preprocessing through relevant regional government websites, relevant statistical departments, authoritative industry reports and other channels. The ranking of the national low-altitude economic development index levels is shown in Table 2.

Table 2. Ranking of National low-altitude economic Development Index levels

Ranking number	Region	Notes	Ranking number	Region	
1	Guangdong	The eastern coast	6	Shandong	The eastern coast
2	Jiangsu	The eastern coast	7	Hubei	Central Region
3	Zhejiang	The eastern coast	8	Shaanxi	Western Region
4	Beijing	North China region	9	Liaoning	Northeast Region
5	Sichuan	Western Region	10	Ji Lin	Northeast Region

According to Table 2, the top low-altitude economic development index is mainly concentrated in the eastern coastal areas. Among them, Guangdong Province, Jiangsu Province, Zhejiang Province and Beijing have established a leading position in the country in terms of low-altitude economic development index, thanks to their well-developed industrial ecosystem and innovation advantages. Sichuan Province, which is located in the western region, ranks fifth, thanks to its solid aviation industry foundation and complete support capacity. The northeastern region and most of the western provinces have a relatively low index of low-altitude economic development due to weak industrial and economic foundations, limited talent and research and development capabilities.

3. CONCLUSIONS AND DISCUSSIONS

This paper conducts an in-depth study of the factors influencing the development of low-altitude economic regions, providing more targeted suggestions for policy-making and industrial development. First, establish a dynamic assessment system to scientifically evaluate and compare regional development levels through multi-dimensional indicators, providing data support for relevant departments to assess regional differences and accurately identify strengths and weaknesses; Second, to drive precise policy-making, formulate differentiated industrial policies based on the technological innovation gradient, market maturity and ecological synergy efficiency reflected by the index, and guide the efficient concentration of factor resources in key areas; Third, promote cross-domain collaboration. Through the complementary space of the industrial chain revealed by the index, build a development pattern of "core leadership - characteristic linkage" and accelerate the formation of a new paradigm for high-quality development of the low-altitude economy.

In the process of constructing the regional development index for the low-altitude economy, although the principles of scientificity, systematicness and representativeness were followed in the selection of indicators, due to the fact that the low-altitude economy is an emerging and rapidly developing field, some indicators may not fully reflect the dynamic changes and potential trends of its development. When assessing the vitality of technological innovation, although indicators such as research and development investment and the number of patent applications were selected, emerging forms of technological innovation such as interdisciplinary innovation cooperation may not be adequately reflected. With the deep integration of the low-altitude economy with other industries and the continuous emergence of new application scenarios and business models, the current indicator system is lacking in reflecting the extent and effect of these integrations.

REFERENCES

[1] Hui Ningning. New Ecology of Low-altitude economy: Shared Unmanned Aerial Vehicles [J]. Legal Person, 2025, (05): 76-78.

[2] Han Songhui. From Exhibition Hall to Blue Sky, Innovation Insurance safeguards the "take-off" of the low-altitude economy [N]. Shanghai Securities News, 2025-05-15 (004).

[3] Regional development dynamics of Low-altitude economy [J]. China Broadband, 2025, 21 (05): 6.

[4] Zhao Dong. Evaluation and Analysis of regional green and Low-Carbon Development Index under dual control of carbon emissions [J]. China Strategic Emerging Industries, 2025, (09): 163-165.

[5] Zhu Dequan, Cao Dufan. Education & Economy, 2024, 40 (05): 3-14. China Vocational Education Modernization Development Index and Regional comparison [J].

[6] Wang, Y., Zhang, F., Feng, Q. et al. Strategic analysis of intelligent connected vehicle industry competitiveness: a comprehensive evaluation system integrating rough set theory and projection pursuit. Complex Intell. Syst. 10, 7033-7062 (2024). https://doi.org/10.1007/s40747-024-01525-w

[7] Wu, Z., Yang, J., Zhang, F. et al. Exploring automobile brand power: A multi - dimensional approach. Environ Dev Sustain (2024). https://doi.org/10.1007/s10668-024-05089-0