Analysis and Decision-making of Regional Economic Vitality and Its Influencing Factors

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Abstract: Since the reform and opening up, China's economy has developed rapidly. However, due to economic, social, natural, historical and other reasons, development has been uneven across regions, and regional economic variability also exists. Therefore, an objective and comprehensive evaluation of regional economic vitality, and exploring the causes of such differences, are of great significance for achieving regional coordination in sustainable development. The so-called economic vitality refers to the growth rate and potential of the total supply and demand in the economy of a city or province in a certain period of time. It involves all aspects of GDP, the living environment of the enterprise, and the living standard of the people. Attraction to capital, labor, entrepreneurship, technological innovation, etc., and efficiency in using these factors. This article takes Henan Province as the research object, similar to China's average economic development, establishes a reasonable analysis model, and analyzes the influencing factors of economic vitality changes from the perspective of population trends and corporate vitality trends.

1. Establishment and Solution of Model

1.1 Question One

1.1.1 Models Establishment

To identify key factors affecting regional economic vitality, we analyze to determine the representation of the dependent and independent variables of the problem. We analyze the factors that affect economic vitality and the GDP of Henan Province in the past 10 years, use an improved neural network model to analyze the factors that affect economic vitality and their impact. The model uses factor analysis to optimize the input variables of the neural network and select more relevant indicators as the model's network input.

(1) Factor analysis method

Basic Idea of Factor analysis method

The factor analysis method mainly groups variables according to the magnitude of the correlation. Represent each variable of the original observation in order to explain the correlation between the original variables and reduce the dimensionality. At the same time, weights reflecting the amount of information contained in the factors and indicators are formed to calculate the comprehensive evaluation value [1]. In this way, the influence of subjective factors is overcome in the selection of index weights, which helps to objectively reflect the actual relationship between samples

(2) Improved Neural Network Model

Basic Idea of Neural Network algorithm

This paper uses a neural network model based on factor analysis and BP neural network algorithm to analyze the degree of influence of various factors on economic vitality. We first used a factor analysis model to screen all the impact indicators, and finally got several key factors affecting economic vitality as input variables of the neural network. The basic idea of the BP neural network is that the learning process consists of two parts: forward signal propagation and backward feedback

error. In forward propagation, input samples are passed in from the input layer, processed by each hidden layer in turn, and then transmitted to the output Layer, if the output layer output does not match the expectation, the error is returned back as the adjustment signal layer by layer, and the connection weight matrix between neurons is processed to reduce the error. The specific network structure of BP neural network is shown in Figure 1 below.

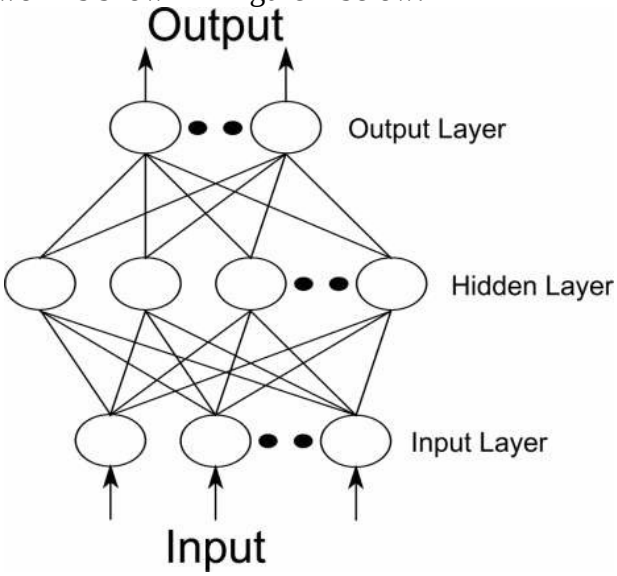

Figure 1 Multilayer feedforward network

1.1.2 Models Solution

(1) Key factors extraction by factor analysis

Principal component extraction was performed on the factors affecting population change, and factor analysis was performed using SPSS software, and the component matrix was obtained as shown in Table 1 below.

From the perspective of the trend of population change, this article selects the total population, the number of employed persons, the degree of aging, the natural change of the population, the level of education, the permanent population, and the ratio of men and women as independent variables. Using correlation analysis, we know that some of the independent variables have a low degree of correlation, which leads to the redundancy of the variables. Analyzing the component matrix, it was found that the four indicators of total population, number of employed persons, natural population changes, and permanent population have a greater impact on economic vitality. Therefore, the above four indicators can be used as key factors affecting economic vitality [2].

Extract the principal components of the factors that affect the change of corporate vitality, and use SPSS software to perform factor analysis. The component matrix obtained is shown in Table 2 below.

Table 1. The component matrix

Component matrix a	Ingredients
Total population	0.999
Number of employees	0.997
Ageing	0.969
Natural population change	0.998
education level	0.975
permanent residents	0.997
Male to female ratio	0.947

Table 2. The component matrix

Component matrix a	Ingredients
Tertiary Industry Enterprise Output Value	0.999
Number of companies	0.997
Total catering retail	0.969
Output value of secondary industry enterprises	0.998
Deposit balance at the end of the financial year	0.945
Real estate investment	0.967
Construction value	0.986
Number of real estate companies	0.973
Construction companies	0.987
Industrial value-added	0.983

In the same way, from the perspective of the trend of population change, the output value of the tertiary industry enterprises, the output value of the secondary industry enterprises, the number of enterprises, and several typical industries that account for a large proportion of the market are initially selected. The factor matrix is used to obtain the component matrix. Finally, the output value of the tertiary industry enterprises, the output value of the secondary industry enterprises, and the number of enterprises are selected as the key factors affecting the regional economic vitality.

(2) Analysis of economic vitality changes based on improved neural network models

The key factors obtained in (1) above are used as input variables of the BP neural network. The degree of influence of these key factors on the regional economy is analyzed through the training results of the neural network model.

In the case of neglecting slight changes in the network, after the principal component analysis, the total population, the number of employed persons, the natural population change, and the resident population were selected as input variables in the population change trend indicators, and the secondary and tertiary industries were selected in the enterprise vitality change trend indicators The output value and the number of enterprises are used as input variables, and GNP is selected as an output variable in the indicators that measure the change in regional economic vitality. Through the establishment of the neural network, we can obtain a structural analysis chart of the neural network. From the figure, we can know the training data. The relationship between the gradient and the mean square error validates the feasibility of this model. The following Figures 2 and 3 are the results of inputting neural network models into the key factors of population change and corporate vitality change, respectively.

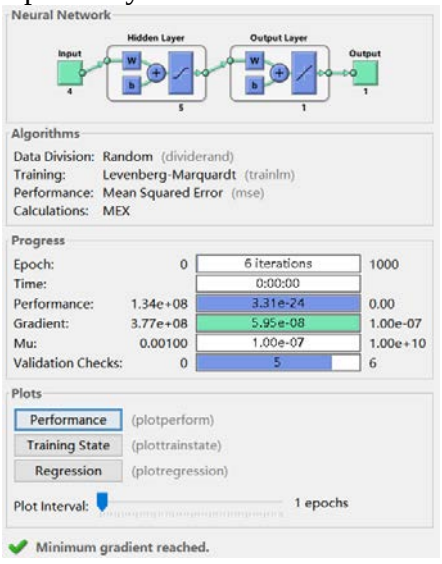

Figure 2. Demographic change results

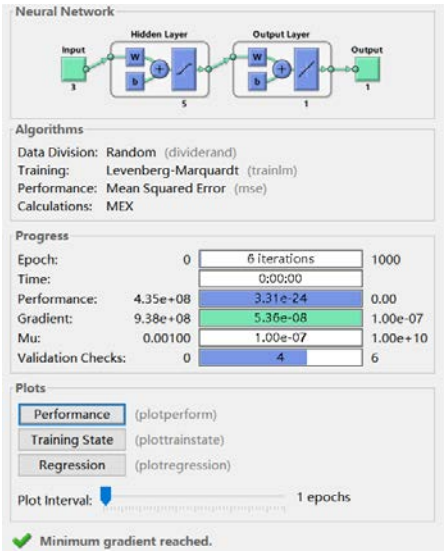

Figure 3. Corporate vitality change results

By analyzing the following Figures 4 and 5, we can obtain the degree of influence of different key factors on regional economic vitality. Observing the results of regression analysis, the correlation can reach 0.99, and the correlation is high. Therefore, the analysis of regional economic vitality changes can use the total population, the number of employees, natural population changes, the permanent population, the output value of the secondary and tertiary industries and the number of enterprises Key factors affecting regional economic vitality.

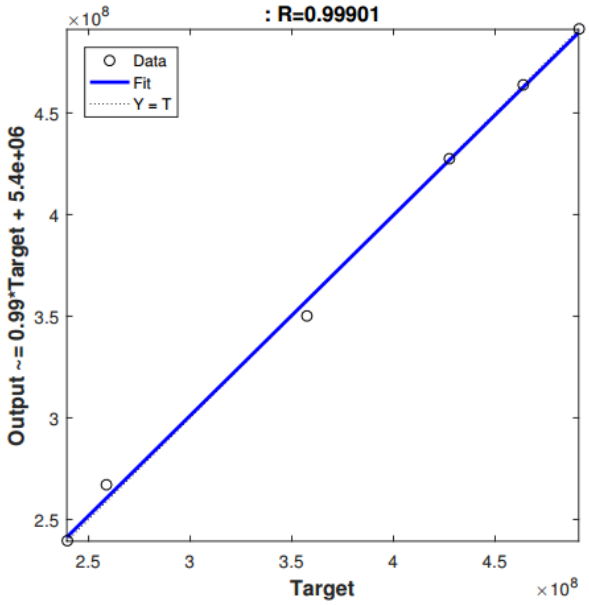

Figure 4. Population

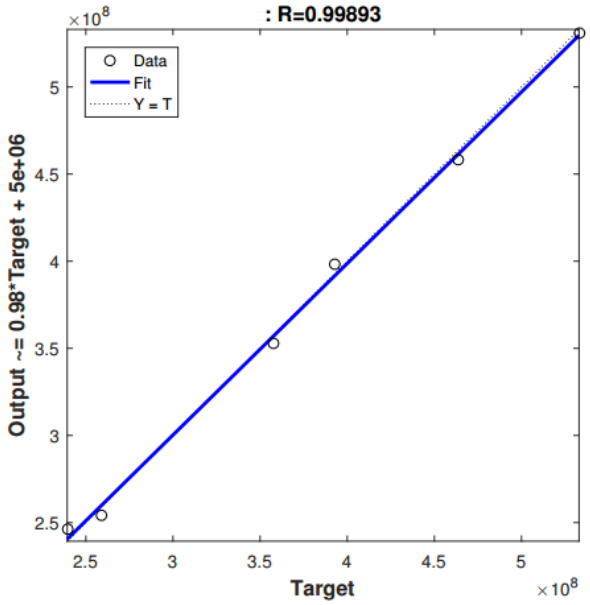

Figure 5. Enterprise Vitality

1.2 Question Two

1.2.1 Models *Establishment*

After data survey and related information query, we decided to analyze the economic policy adopted by Henan Province in 2008 to quantitatively analyze the economic vitality change of Henan Province before and after the implementation of this economic policy change. This paper considers using the gray prediction model GM (1,1) to analyze the short-term and long-term effects on regional economic vitality after economic policy transition. Gray prediction is a prediction for gray systems, which can identify the degree of disparity in development trends between system factors, performs correlation analysis, and generates and processes the original data to find the rules of system changes, generates data sequences with strong regularity, and establishes corresponding differential equations Model to predict the future development of things. It constructs a gray prediction model with a series of quantitative values of the characteristics of the prediction object observed at equal time intervals, and predicts the feature quantity at a certain time in the future, or the time to reach a certain feature quantity[3].

1.2.2 Models *Solution*

According to the establishment of the above model, we use MATLAB software to predict the analysis of factors that reflect economic vitality in turn using the gray forecast method based on data before 2008. Due to too many factors selected, we only show GDP and total fixed asset investment in the entire society The forecast and analysis results of four factors, total retail sales of social consumer goods and household consumption level, and relevant conclusions are given. As shown in Figure 6, the forecast results of the above four factors are shown, and the impact of economic policy changes on each factor after 2008 in practice.

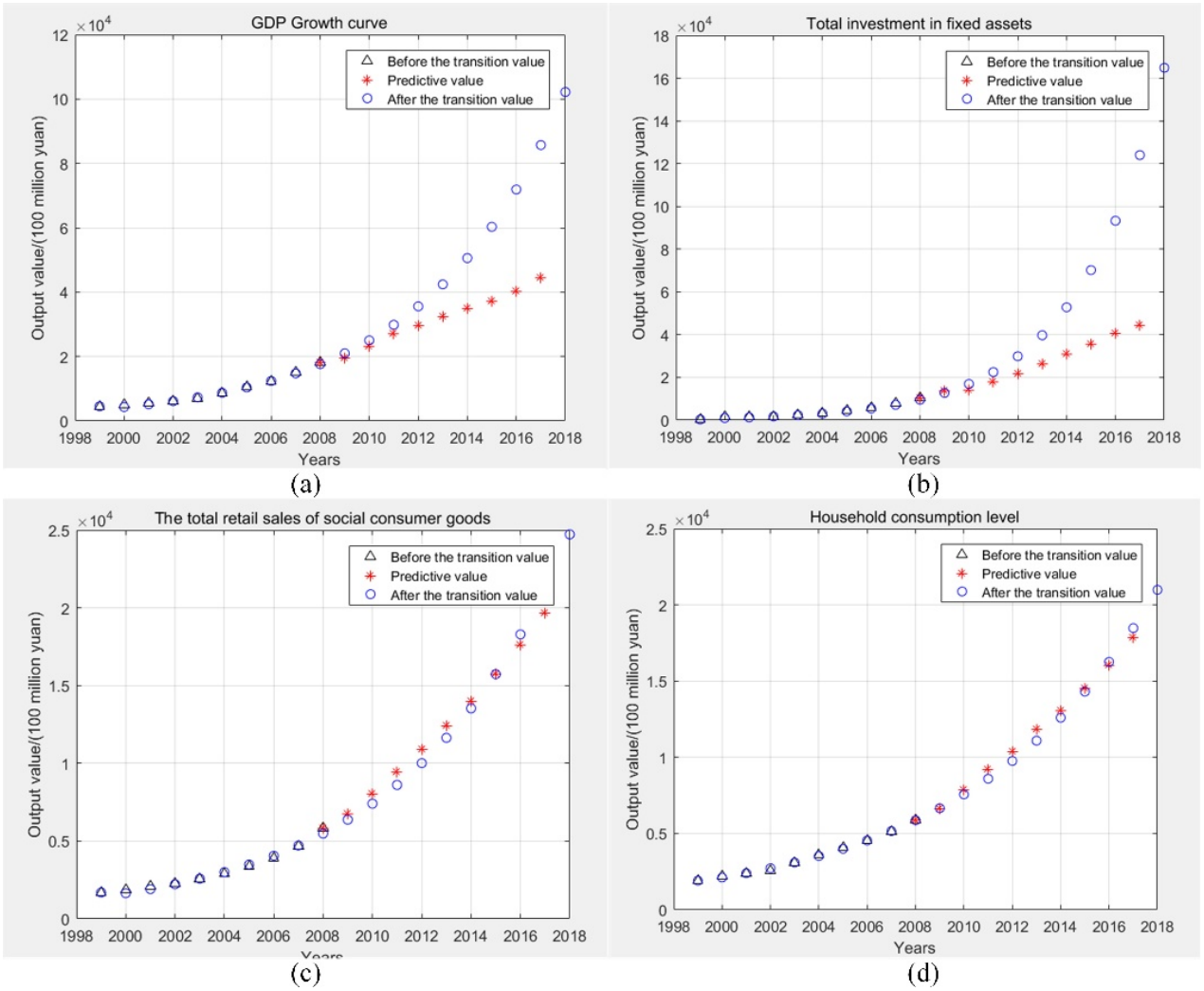

Figure 6 (a)GDP Forecast Results. (b)Forecast Results of Total Fixed Asset Investment. (c)Forecast Results of Total Retail Sales of Consumer Goods. (d)Forecast Results of Household Consumption Level.

Analyzing the above forecast results, we find that after the implementation of economic policy changes (after 2008), the two factors of GDP and total fixed asset investment in the region have not changed much in the short term, and the values after the implementation of the policy are not significantly different. The long-term time change, the value difference after the implementation of the policy gradually increases, and the value after the economic policy change is generally larger than the predicted value; obviously, the two factors of the economic policy change on the total retail sales of consumer goods and the level of household consumption in the short and long term The impact is consistent, and there are no significant differences before and after economic policy changes[4].

Therefore, in the short term, the change in regional economic policies will have a minor effect on regional GDP, total output value of enterprises, and total investment in fixed assets. The factors have no obvious influence; in the long run, the change of regional economic policy has a very obvious driving effect on the main factors for measuring economic vitality, which can fully improve the local economic vitality.

1.2.3 Models Test

We use the posterior error test method to check the accuracy of the model. Let the $\hat{X}^{(0)}$ and residuals that have been obtained according to the GM (1,1) modeling method, and the variances of the original sequence $X^{(0)}$ and the residual sequence E are S_1^2 and S_2^2 respectively, then:

$$S_1^2 = \frac{1}{n}\sum_{k=1}^{n}\left[x^{(0)}(k) - \bar{x}\right]^2$$
$$S_2^2 = \frac{1}{n}\sum_{k=1}^{n}[e(k) - \bar{e}]^2 \quad (1)$$

among them, $\bar{x} = \frac{1}{n}\sum_{k=1}^{n} x^{(0)}(k), \bar{e} = \frac{1}{n}\sum_{k=1}^{n} e(k).$ (2)

Calculate the posterior error ratio $C = S_2/S_1$ and calculate the small error probability $p = P\{|e(k) - \bar{e}| < 0.6745S_1\}$. The smaller the index C is, the better the p is. Generally, the accuracy level of the model is divided into four levels, as shown in Table 3.

Table 3. Reference Table for Accuracy Inspection Level

Model accuracy level	Mean square error ratio C	Small error probability p
Level 1 (good)	$C <= 0.35$	$0.95 <= p$
Level 2 (qualified)	$0.35 < C <= 0.5$	$0.80 <= p < 0.95$
Level 3 (reluctantly)	$0.5 < C <= 0.65$	$0.70 <= p < 0.80$
Level 4 (Disqualified)	$0.65 < C$	$p < 0.70$

The test results obtained by running with MATLAB are shown in Table 4.

Table 4. Reference Table for Accuracy Inspection Level

Inspection standards	GDP	Total investment in fixed assets	The total retail sales of social consumer goods	Household consumption level
Variance ratio C	0.074	0.1044	0.1134	0.0614
Small error probability P	1	1	1	1

The model established according to the data and accuracy test level reference table in the above table conforms to the model accuracy level 1, which proves that our prediction model is reasonable.

1.3 Question Three

1.3.1 Models Establishment

Basic principles of Cluster Analysis

The principle of cluster analysis is to solve the ranking problem in multi-index system evaluation. In order to avoid the variance contribution rate of the first principal component is not high enough, only the first principal component score brings the one-sidedness of the sample ranking evaluation. Cluster analysis is a combination of these two methods, using the "Principal Component Cluster Analysis" method. Cluster analysis is a multivariate statistical analysis method that can reasonably classify samples or indicators according to their characteristics. Although cluster analysis can classify multi-indicator data, it cannot obtain the evaluation results of various pros and cons.

1.3.2 Models Solution

In order to comprehensively analyze and measure the vitality of the regional econ- omy, this article selects some representative economic influencing factors. According to the conclusion of Question 1, it can be known that the trend of population change and the trend of corporate vitality have a strong positive correlation with regional economic vitality. Therefore, the correlation analysis and component extraction of each index can be performed here to reduce the complexity of the evaluation index [5-6].

Table 5. Factor Comorrelation Matrix

Relevance Economic Increment	Enterprises Number	Residents Income	Foreign Capital	Educational Level	Population
Economic 1	0.995	0.696	0.469	0.597	0.91
Increment Enterprises 0.995 Number	1	0.245	0.459	0.402	0.895
Residents 0.696 Income	0.245	1	0.121	0.674	0.423
Foreign 0.469 Capital	0.459	0.121	1	0.2	0.413
Educational 0.597 Level	0.402	0.674	0.2	1	0.746
Population 0.91	0.895	0.423	0.413	0.746	1

According to the correlation analysis in Table 5, it can be known that the above- mentioned indicators are close to 1 with the number of enterprises, the annual average income of the enterprise, and the registered capital of the enterprise, so they can be replaced by linear expressions or direct variables.

According to the attached information, the number of enterprises is an important indicator of regional economic vitality. The number of enterprises can directly affect the existing employment opportunities. It greatly promotes the circulation of resources and determines the economic benefits of enterprises. In order to reduce the complexity of the model solution, different cities can be classified according to the number of new and cancelled enterprises in the past ten years, so as to establish a comprehensive evaluation model of factor cluster analysis [7].

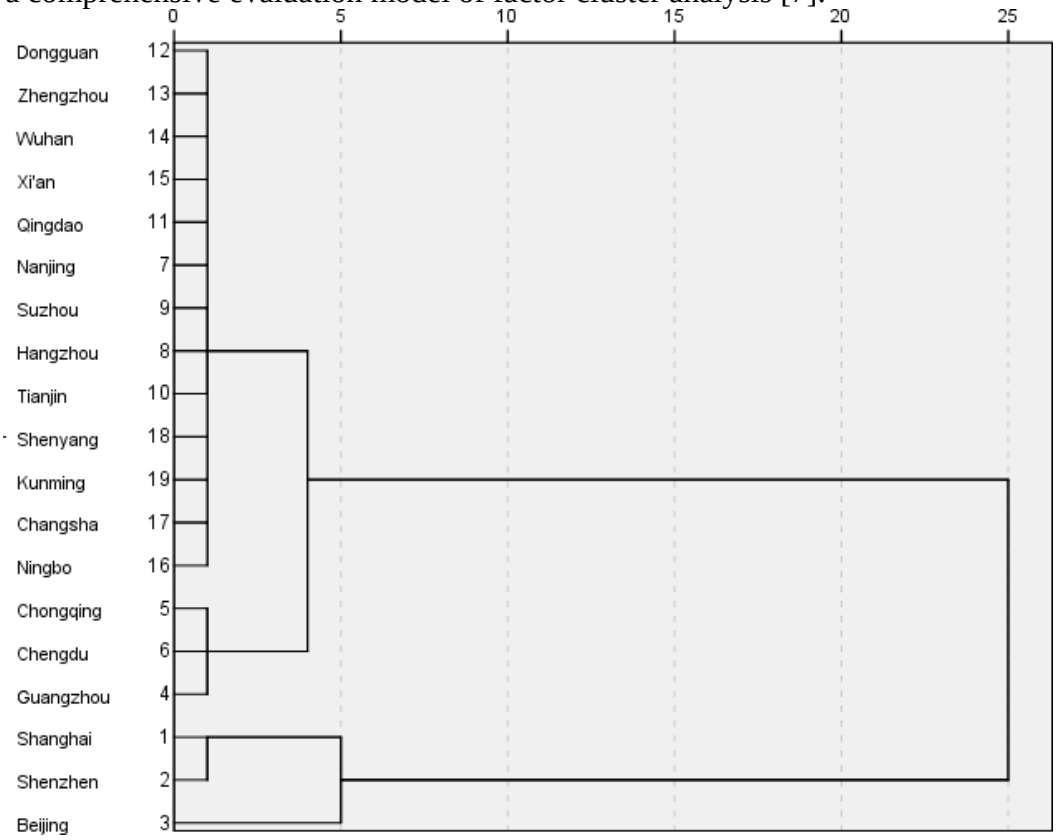

Figure 7 Clustering Treemap for Each City

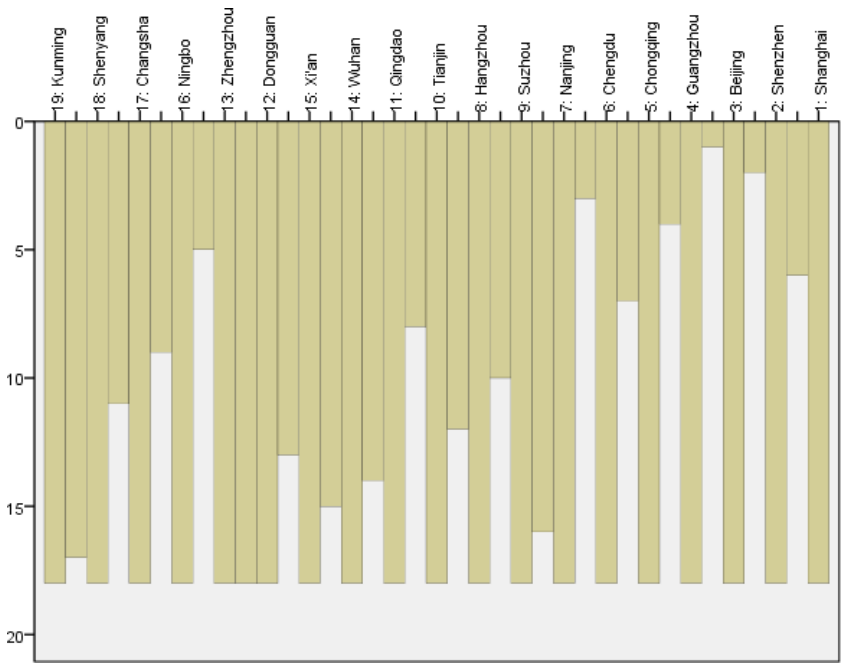

Figure 8 Clustered Icicles for Each City

As can be seen from Figure 7-8, if the cities in the annex are divided into two categories, Beijing, Shenzhen, and Shanghai are classified into one category, which roughly conforms to the classification of first-tier cities and second-tier cities. If divided into four categories, Beijing is classified as one category, Shanghai and Shenzhen are classified as one category, Chongqing, Chengdu and Guangzhou are classified as one category, and the remaining other cities are classified as one category. Further solution analysis is underway.

First, an index set matrix of each independent variable is established according to the comprehensive index system, and the matrix data is standardized. Then, the evaluation indexes of each index and index set are calculated separately, and finally, the urban economic vitality evaluation index is calculated.

Table 6 shows the eigenvalues of each component, the variance contribution rate and the cumulative variance contribution rate of each principal factor. The inverse compact transformation is solved to obtain the corresponding feature vector. It is further possible to determine the principal component and calculate the factor load in the case of the relative importance of the principal factor.

Table6 Eigenvalue and Main Factor Contribution Rate

Principal factor	characteristic value	Contribution rate	Cumulative contribution rate
1	6.456	27.47608185	27.47608185
2	6.357	27.05474788	54.53082973
3	5.877	25.01191652	79.54274625
4	2.215	9.426815566	88.96956181
5	1.318	5.609274454	94.57883627
6	0.607	2.583330496	97.16216676
7	0.309	1.315072691	98.47723945
8	0.17	0.723502775	99.20074223
9	0.125	0.531987334	99.73272956
10	0.049	0.208539035	99.9412686
11	0.0138	0.058731402	100

Calculation formula as follows:

$$L_{ij} = \sqrt{\lambda_i} l_{ij}$$
$$H_{ij} = L_{ij} P_j \quad (3)$$

Among them, λ is the eigenvalue, I is the eigenvector, P is the main factor, and L is the factor load.

Finally, the city's economic vitality index table obtained based on the model. The city's economic vitality ranking in Annex 3 is Shenzhen, Shanghai, Guangzhou, Dongguan, Suzhou, Beijing, Ningbo, Hangzhou, Tianjin, Qingdao, Nanjing, Shenyang, Kunming, Wuhan, Changsha, Chengdu, Zhengzhou, Xi'an, Chongqing.

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