# Application of Discrete Mathematics in the Evaluation Model of Regional Economic Growth Effect

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**Abstract: At present, the evaluation of regional economic growth effect, the consistency test results of evaluation indexes are not accurate, which leads to the phenomenon of "pseudo regression" in the evaluation model, so the application of discrete mathematics in the evaluation model of regional economic growth effect is proposed. Based on the selection principle of regional economic growth effect index put forward in the literature, the evaluation index of regional economic growth effect is determined to measure the location entropy existing in the evaluation index; to deal with the difference of evaluation index data, KMO test and Bartley sphericity test are adopted. Besides the evaluation index layer of economic distribution standard, the test results show that the evaluation index data is suitable for factor analysis method. The evaluation index weight is calculated, and the regional economic growth effect evaluation model is established to evaluate the regional economic growth effect by using the compactness of the combination of discrete mathematics and data and the characteristics of its discretization.**

**Keywords: Discrete Mathematics; Regionality; Economic Growth Effect; Evaluation Model Construction;**

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## Introduction

At present, foreign scholars' research on regional economy can be roughly divided into three stages: the first stage is about using regional multiplier theory to study the effect of regional economic growth; the second stage is to use input-output model, general equilibrium model and regional satellite account to evaluate the impact of regional economic growth; the third stage is to use conceptual model and mathematical model This paper studies the influence of type on regional economy. All in all, foreign scholars' research on regional economy mainly focuses on the impact of regional economic growth on social economy and environment, among which the most important is to elaborate the impact of regional economy on national economy [1].

In contrast to the effect of foreign countries on regional economic growth, the evaluation of regional economic growth effect in China started late. At the beginning of the research, the evaluation of regional economic growth effect mainly depends on the subjective experience of authoritative scholars and senior practitioners, most of which belong to qualitative research. In the study of regional economic growth effect, when entering the stage of research and development, domestic scholars began to pay attention to and absorb the theories and methods of regional economic growth effect evaluation abroad, and gradually learn from these methods and models, but the specific application examples are insufficient. Therefore, many domestic scholars are committed to the study of regional economic growth effect. In the process of studying the effect of regional economic growth, cluster analysis and principal component analysis are used to study the current situation of China's regional economic development. It is found that the regional economic growth in China shows a trend of unbalanced development, and there are large differences in economic growth among regions, uneven distribution of regional economic development, education and employment among regions.Many domestic scholars, when studying the effect of regional economic growth in China, take the income of each region in China as a measure index, analyze the difference of economic growth in each region through the statistical indexes such as standard deviation, range, extreme value ratio and coefficient of variation, and compare the standard deviation and coefficient of variation, so as to make progress in unbalanced economic development of each region in China in recent years In depth comparative analysis [2].

At present, the theory and method of discrete mathematics are widely used in digital circuit, compiling principle, data structure, operating system, database system, algorithm analysis and planning, artificial intelligence, computer network construction. The object of its study is discrete quantitative relation, discrete structure and mathematical structure model. Computer is a discrete structure, which can only deal with discrete or discretized quantitative relations. No matter computer science itself or the scientific field closely related to computer science, it is faced with how to establish the corresponding mathematical model of discrete structure, how to discretize the mathematical model established by connecting the connected quantities, and then it can be dealt with by computer, and establish regional economic growth effect model [3].

Literature [4] uses Solow residual value method to measure the contribution rate of labor, capital and technological progress to China's regional economic development, and finds that the growth of capital and labor factors can best promote China's regional economic development. Literature [5] analyzes the historical panel data, and finds that the main factor to promote regional economic growth is not due to technological progress, but depends on the input of production factors. Literature [6] uses two-stage nested Theil coefficient decomposition method to analyze China's regional economy in recent years, reveals the changing characteristics of regional differences and its contribution rate to the overall national differences. Literature [7] uses the multivariate statistical method to evaluate the regional economy and finds that there is a significant imbalance in the economic development among regions in China. Some regional economies have developed rapidly in recent years, but some regional economies have developed very slowly, even without growth [4-7]. Therefore, through a large number of literature research, many scholars in the process of studying regional economic growth effect, mainly limited to linear regression, gray correlation, measurement methods and the combination of various methods, etc., the types of research methods need to be further expanded. Through the study of the existing literature, it is found that the research on the influence factors of regional economic growth effect is relatively mature, but the research on the effect of regional economy is in the initial stage, which needs further study.

## 2 Construction of regional economic growth effect evaluation model based on Discrete Mathematics

### 2.1 Determine the evaluation index of regional economic growth effect

Referring to the regional economic growth effect proposed in literature [8], the selection principle of evaluation index, and the availability of regional economic growth data, this study studies the evaluation model of regional economic growth effect, and constructs the evaluation index system of regional economic growth effect as shown in Table 1 [8]. The index system is divided into three layers, the target layer is the effect of regional economic growth, the criterion layer is divided into five aspects: regional scale, economic distribution, economic growth, economic strength and opening to the outside world, and the index layer includes 29 specific indicators.

**Table 1 Evaluation index system of regional economic growth effect**

| Target layer | Criteria layer | Primary index | Secondary index |
|---|---|---|---|
| Regional economic growth effect | Regional scale (A) | Extension (AX1) | Regional population (AX11) |
| | | | Number of regional listed companies (AX12) |
| | | | Regional Area (AX13) |
| | | Connotation (AX2) | Regional structure (AX21) |
| | | | Regional function (AX22) |
| | | | Regional quality (AX23) |
| | Economic distribution (B) | Economic concentration (BX1) | Regional industrial value (BX11) |
| | | | Number of regional industries (BX12) |
| | | | Regional economic scale (BX13) |
| | | | Employed persons (BX14) |
| | | | Per capita income (BX15) |
| | | | Per capita expenditure (BX16) |
| | | | Regional economic income (BX17) |
| | | | Number of listed companies (BX18) |
| | | Economic diffusion (BX2) | Location entropy of regional employees(BX21) |
| | | | Location entropy of economic output value (BX22) |
| | Economic growth (C) | Regional overall (CX1) | Regional asset growth rate (CX11) |
| | | | Regional GDP growth rate (CX12) |
| | | Per capita (CX2) | Growth rate of regional per capita deposit (CX21) |
| | | | Regional per capita deposit and loan growth rate (CX22) |
| | Economic | Economic aggregate | Regional GDP (DX11) |

| | | |
|---|---|---|
| strength (D) | (DX1) | Regional fixed asset investment (DX12) |
| | | Regional financial revenue (DX13) |
| | Per capita distributive economy (DX2) | Regional per capita GDP (DX21) |
| | | Regional per capita disposable income (DX22) |
| Opening to the outside world (E) | Export (EX1) | Regional foreign direct investment (EX11) |
| | | Regional export economy (EX12) |
| | Inport (EX2) | Regional import economy (EX21) |
| | | Regional actual utilization of foreign capital (EX22) |

Regional scale is the foundation of regional economic development and the direct embodiment of regional economic strength. Therefore, from the two aspects of the extension (AX1) and connotation (AX2) of the region, this paper summarizes the regional scale (A), and selects the regional population, the number of listed companies, quality, function, structure and other aspects to evaluate the regional scale. Economic efficiency can promote the formation of regional economic agglomeration and radiation, and it can also determine whether a region realizes economic industry agglomeration and the main factors of the degree of agglomeration [9]. Therefore, from the two aspects of economic concentration (BX1) and economic diffusion (BX2), this paper summarizes economic distribution (B), and selects the number of employees, per capita income, expenditure and other aspects to evaluate the regional scale. Therefore, the flow of regional economy can be reflected in two directions: the high-quality regional economy is concentrated in the core region, while the low-end regional economy is spread to the surrounding areas. Generally speaking, the higher the degree of regional economic agglomeration is, the more concentrated high-quality regional resources, the greater the radiation and impact on the surrounding areas.

Financial growth rate can reflect the development potential of regional financial industry. Therefore, the regional economic growth rate is reflected from the overall (CX1) and per capita (CX2) of the region, and the regional GDP growth rate, regional per capita deposit and loan growth rate are selected to evaluate the regional economic growth. Economic strength is an important embodiment of regional economic development. When the regional economic development reaches a certain degree, it can promote the sustainable development of regional economy and form a good win cycle of economic development - shallow level economic agglomeration - economic sustainable development - deep level economic agglomeration. Therefore, the regional economic strength (D) is measured from two aspects: the total economic volume (DX1) and the per capita distributive economy (DX2), and the regional economic strength is specifically evaluated in terms of regional fixed investment assets, regional per capita GDP, regional fiscal revenue, etc. Among them, there is a positive correlation between the total economic volume (DX1) and the level of economic development, which can promote the formation and development of regional economic agglomeration [10].

The higher the degree of opening to the outside world, the more conducive to the spatial flow and agglomeration of regional economy, and thus the more effective to promote regional economic development. Therefore, from the export (EX1) and import (EX2) two aspects to reflect the opening degree of the regional economy, and select the regional investment assets, the actual use of assets, regional import and export economy to evaluate the opening degree of the regional economy. Based on the literature [11], it can be seen that the greater the regional foreign direct investment, the actual use of foreign capital and the amount of import and export trade, indicating that the region is an export-oriented economy, which is greatly affected by the world economic environment and can reasonably allocate resources in a larger range, thus indicating that the level of economic development in the region is higher [11]. Due to the diffusion of regional economic distribution index, it can reflect the effect of regional economic growth on the surrounding areas. Therefore, regional economic distribution index is measured by location entropy.

**2.2Measuring regional economic distribution index**

The diffusion of regional economy reflects the influence of regional economy on surrounding areas, so the regional economic distribution is measured by location entropy. Location entropy is the specialization rate. Based on the cluster identification method, it measures the relative concentration of an industry in the region [12]. Therefore, if the region is $j$, the industry is $i$, and the total number of employees in China is $G$, then there is a formula for calculating the location entropy $Lq$ of regional employees:

$$Lq_{ij} = \frac{\frac{G_{ij}}{G_i}}{\frac{G_j}{G}} \qquad (i = 1, 2, 3, \text{L}, n; j = 1, 2, 3, \text{L}, m) \tag{1}$$

In the formula(1), $G_{ij}$ is the number of employees in industry $i$ of $j$ region, $G_j$ is the number of employees in industry $i$, GG is the number of employees in industry $i$ of $j$ region, $Lq_{ij}$ is the location entropy of employees in industry $i$ of $j$ region. When $L_{ij} < 1$, the proportion of all employees in $j$ region allocated to a certain industry in this region will not be higher than that in the whole country, so the employees in industry $i$ in $j$ region will not have the outward function effect; if $L_{ij} > 1$, the proportion of all employees in $j$ region allocated to an industry in this region will exceed that in the whole country, that is, the proportion in industry $i$ in $j$ region Compared with the national average level, the industry is a specialized sector, so the employees in $j$ region have an outward function, which can provide services for the external region [13].

If the output value of financial industry of industry $i$ is $Y$ and the location entropy of economic output value is $Ly$, then:

$$Ly_{ij} = \frac{\frac{Y_{ij}}{Y_i}}{\frac{Y_j}{Y}} \qquad (i = 1, 2, 3, \text{L}, n; j = 1, 2, 3, \text{L}, m) \tag{2}$$

In the formula(2), $Y_{ij}$ is the economic output value of $j$ region $i$ industry, $Y_i$ is the total output value of $i$ industry, $Y_j$ is the total output value of $j$ region, $Ly_{ij}$ is the location entropy of economic output value of $j$ region $i$ industry. If $Ly_{ij} > 1$, it indicates that the economic output value of $j$ region has export-oriented function; otherwise, if $Ly_{ij} < 1$, the economic output value of $j$ region does not have export-oriented function effect. On the basis of measuring the regional economic distribution index, this paper deals with the data of the regional economic growth effect evaluation index, so as to calculate the weight of the regional economic growth effect evaluation index in a suitable way.

**2.3Data consistency test**

In the process of collecting regional economic growth effect evaluation indexes, there will be some differences in the collected data. Therefore, the collected regional economic growth effect evaluation index data will be standardized conversion, that is, the index of statistical data. Since the regional economic distribution index has been measured in section 1.2, in this section, the regional economic growth effect evaluation index data of standardized transformation does not include regional employment location entropy and economic output location entropy. Therefore, if the actual variable value of $j$ region $i$ industry is $x_{ij}$, the original data mean value of $j$ region is, the standard deviation of $j$ region is $s_i$, and the variable value of $j$ region $i$ industry standardization is $z_{ij}$, then:

$$z_{ij} = \frac{x_{ij} - x_i}{s_i} \tag{3}$$

In the formula(3), the standardized regional economic growth effect evaluation index data will fluctuate around zero. When $z_{ij} > 0$, it shows that formula (3) calculated regional economic growth effect evaluation index is significantly higher than the average level; when $z_{ij} < 0$, it shows thatformula (3) calculated regional economic growth effect evaluation index is significantly lower than the average level.

The results calculated by formula (3) need to pass the consistency test to judge whether the regional economic growth effect evaluation index data is suitable for factor analysis. Therefore, KMO test and Bartley sphericity test are used in this study to determine whether the regional economic growth effect evaluation index data is suitable for factor analysis. The test results show that the KMO value of the regional economic growth effect evaluation index data has reached 0.782, and the probability P value corresponding to Bartlett sphericity test is 0.000. According to the kmo measurement standard and Bartley sphericity measurement standard, we can know that, regional economic growth effect, the assumption of independence among various evaluation indexes is not tenable, sample data is more suitable for factor analysis, and the weight of evaluation indexes of regional economic growth effect is calculated.

**2.4 Calculate the weight of regional economic growth effect evaluation index**

In Table 1, 8 indexes reflecting regional economic concentration and 2 indexes reflecting regional economic diffusion are selected to reflect regional economic distribution degree as a whole; 3 indexes reflecting economic aggregate and 2 indexes reflecting per capita distribution are selected to reflect regional economic strength as a whole [14]. Formula (3) is used to calculate the regional economic distribution and economic strength evaluation index. After consistency test, KMO value has reached 0.7764 and 0.8651, and the probability P value corresponding to Bartlett sphericity test is 0.000. The results of regional economic distribution effect factor analysis are shown in Table 2.

**Table 2 Factor analysis of economic distribution and economic strength**

| Component | Factor load | | | Common factor load | | | Common factor load after rotation | | |
|---|---|---|---|---|---|---|---|---|---|
| | Characteristic value | Variance contribution rate | Cumulative variance contribution rate | Characteristic value | Variance contribution rate | Cumulative variance contribution rate | Characteristic value | Variance contribution rate | Cumulative variance contribution rate |
| 1 | 5.605 | 0.8007 | 0.8007 | 5.605 | 0.8007 | 0.8007 | 0.605 | 0.8007 | 0.8007 |
| 2 | 0.883 | 0.1262 | 0.9269 | | | | | | |
| 3 | 0.385 | 0.0550 | 0.9819 | | | | | | |
| 4 | 0.066 | 0.0094 | 0.9913 | | | | | | |
| 5 | 0.028 | 0.0040 | 0.9953 | | | | | | |
| 6 | 0.018 | 0.0025 | 0.9979 | | | | | | |
| 7 | 0.015 | 0.0021 | 1.0000 | | | | | | |
| 8 | 0.093 | 0.0116 | 0.9896 | | | | | | |
| 9 | 0.054 | 0.0067 | 0.9963 | | | | | | |
| 10 | 0.030 | 0.0038 | 1.0000 | | | | | | |
| 11 | 5.226 | 0.6533 | 0.6533 | 5.226 | 0.6533 | 0.6533 | 4.148 | 0.5185 | 0.5185 |
| 12 | 1.249 | 0.1561 | 0.8094 | 1.249 | 0.1561 | 0.8094 | 2.326 | 0.2908 | 0.8094 |
| 13 | 0.888 | 0.1110 | 0.9204 | | | | | | |
| 14 | 0.293 | 0.0266 | 0.957 | | | | | | |
| 15 | 0.168 | 0.0210 | 0.978 | | | | | | |

It can be seen from table 2 that there is only one common factor in economic distribution, and its characteristic value of common factor is greater than 1, while the characteristic value of other factors is relatively small, and the cumulative variance contribution rate of the common factor reaches 80.07%, indicating that most of the information of the original data can be provided, replacing all 10 original variables, to explain the degree of regional economic distribution. But the economic strength has two public factors, and the first two public factors' eigenvalues are greater than 1, the other factors' eigenvalues are smaller, and the cumulative variance contribution rate of the first two public factors has reached 80.94%, which shows that these two factors can provide most of the information of the original data, and can replace the five original variables to explain the economic strength. Therefore, there is no change between the result of economic distribution after rotation and the factor variable before rotation. Compared with the factor variables before and after rotation, the economic strength found that many variables after rotation have higher load. Therefore, Using Stata software, it can be concluded that the comprehensive score function $F_B$ of regional economic distribution and the function coefficient $F_D$ of economic strength factor score are as follows:

$$\begin{cases} {F_B}^2 = 0.8007 f_B \\ {F_D}^2 = 0.5185 f_{D1} + 0.2908 f_{D2} \end{cases} \tag{4}$$

In formula (4), $f_B$ is the public factor of economic strength factor, $f_B$ and $f_{D2}$ are the public factors of economic strength factor. Therefore, factor process is used to extract $f_B$, $f_{D1}$ and $f_{D2}$ common factors for the next analysis. After the load matrix is orthogonal rotated to maximize the variance, the rotated factor load matrix table is obtained, as shown in Table 3.

**Table 3 Factor load matrix**

| Common factors / Factors | $f_B$ | |
|---|---|---|
| Regional industrial value (BX11) | 0.9807 | |
| Number of regional industries (BX12) | 0.9723 | |
| Regional economic scale (BX13) | 0.9808 | |
| Employed persons (BX14) | 0.9689 | |
| Per capita income (BX15) | 0.9743 | |
| Per capita expenditure (BX16) | 0.4969 | |
| Regional economic income (BX17) | 0.6699 | |
| Number of listed companies (BX18) | 0.5682 | |
| Location entropy of regional employees (BX21) | 0.1934 | |
| Location entropy of economic output value (BX22) | 0.7752 | |
| | $f_{D1}$ | $f_{D2}$ |
| Regional GDP (DX11) | 0.8558 | 0.4491 |

| | | |
|---|---|---|
| Regional fixed asset investment (DX12) | 0.3685 | 0.6619 |
| Regional financial revenue (DX13) | 0.0452 | -0.8245 |
| Regional per capita GDP (DX21) | 0.8514 | 0.4117 |
| Regional per capita disposable income (DX22) | 0.5892 | 0.6699 |

Table 3 shows the internal relationship between the public factor $f_B$ of economic distribution and 10 evaluation indexes; the internal relationship between the two public factors $f_{D1}$ and $f_{D2}$ of economic strength and 5 evaluation indexes. It can be seen from table 3 that in the secondary indicators of the economic distribution criteria layer, the proportion of regional industrial value (BX11), the proportion of regional industrial quantity (BX12), the proportion of regional economic scale (BX13), the proportion of employed persons (BX14), the proportion of per capita income (BX15), the proportion of per capita expenditure (BX16), the proportion of regional economic income (BX17), the proportion of listed companies (BX18), only the location entropy of economic output value (BX22), which can better explain $f_B$; the explanation power of regional employment personnel location entropy (BX21) is not significant enough. In the second level indicators of economic strength criterion level, the regional GDP ratio (DX11), the regional fixed asset investment ratio (DX12), the regional per capita GDP ratio (DX21) can better explain $f_{D1}$; the per capita GDP ratio (G2), the regional fiscal revenue ratio (DX13) and the regional per capita disposable income ratio (DX22) can better explain $f_{D2}$.

In addition to the above two indicators, this study also selects three indicators reflecting the regional development trend, namely, regional scale (A), regional economic growth (C), and opening up (E), to reflect the effect of regional economic growth. Based on the evaluation index of regional economic growth effect in Table 1, the evaluation index of regional economic strength is calculated by formula (3). After consistency test,KMO value has reached 0.6323, and the probability p value corresponding to Bartlett sphericity test is 0.000. The analysis result of regional economic distribution effect factor is shown in table 4.

**Table 4 Factor analysis table reflecting regional development trend**

| Component | Factor load | | |
|---|---|---|---|
| | Characteristic value | Variance contribution rate | Cumulative variance contribution rate |
| 1 | 4.621 | 0.5776 | 0.5776 |
| 2 | 2.807 | 0.9357 | 0.9357 |
| 3 | 2.6588 | 0.1156 | 0.8660 |
| 4 | 2.4575 | 0.1068 | 0.5623 |
| 5 | 1.8701 | 0.0813 | 0.8660 |
| 6 | 1.369 | 0.1711 | 0.7478 |
| 7 | 0.847 | 0.1059 | 0.8546 |
| 8 | 0.569 | 0.0711 | 0.9257 |
| 9 | 0.376 | 0.0470 | 0.9727 |

| | | | |
|---|---|---|---|
| 10 | 0.153 | 0.0191 | 0.9918 |
| 11 | 0.046 | 0.0057 | 0.9976 |
| 12 | 0.020 | 0.0024 | 1.000 |
| 13 | 0.123 | 0.0409 | 0.9766 |
| 14 | 0.070 | 0.234 | 1.0000 |

| Component | Common factor load | | | Common factor load after rotation | | |
|---|---|---|---|---|---|---|
| | | Characteristic value | Variance contribution rate | Cumulative variance contribution rate | | Characteristic value |
| 1 | 4.621 | 0.5776 | 0.5776 | 4.244 | 0.5304 | 0.5304 |
| 2 | 1.369 | 0.1711 | 0.7478 | 1.746 | 0.2183 | 0.7478 |
| 3 | 2.807 | 0.9357 | 0.9357 | 2.807 | 0.9357 | 0.9357 |

It can be seen from table 4 that the eigenvalues of the first three public factors are greater than 2, the eigenvalues of other factors are smaller, and the cumulative variance contribution rate of the first three public factors has reached 74.78%, which shows that these three factors can provide most of the information of the original data and can replace 14 original variables to explain the regional economic growth. Comparing the factor variables before and after rotation, it is found that many variables after rotation have higher loads. Therefore, we can use STATAsoftware to get the function coefficients of factor scores. If the comprehensive score functions of regional scale (A), regional economic growth (C), and opening up (E) are $F_U$, $F_U$ and $F_U$ respectively, then:

$$\begin{cases} F_A^{\ 2} = 0.5304 f_{A1} + 0.2183 f_{A2} + 0.9357 f_{A3} \\ F_C^{\ 2} = 0.5304 f_{C1} + 0.2183 f_{C2} + 0.9357 f_{C3} \\ F_E^{\ 2} = 0.5304 f_{E1} + 0.2183 f_{E2} + 0.9357 f_{E3} \end{cases} \tag{5}$$

In formula (5), $f_{A1}$, $f_{A2}$, $f_{A3}$, $f_{C1}$, $f_{C2}$, $f_{C3}$, $f_{E1}$, $f_{E2}$ and $f_{E3}$ are the public factors of regional scale (a), regional economic growth (c), and opening up (E), respectively. At this time, factor process is used to extract $f_{A1}$, $f_{A2}$, $f_{A3}$, $f_{C1}$, $f_{C2}$, $f_{C3}$, $f_{E1}$, $f_{E2}$ and $f_{E3}$ common factors, and the factor load after rotation in Table 4 is rotated orthogonal to maximize the variance, so as to obtain the factor load matrix after rotation, as shown in Table 5.

**Table 5 Factor load matrix**

| Common factors / Factors | $f_{A1}$ | $f_{A2}$ | $f_{A3}$ |
|---|---|---|---|
| Regional population (AX11) | 0.1608 | 0.1955 | 0.3058 |
| Number of regional listed companies (AX12) | 0.1500 | 0.7761 | 0.1450 |
| Regional Area (AX13) | 0.1075 | 0.1624 | 0.1122 |
| Regional structure (AX21) | 0.0591 | 0.1470 | 0.0389 |

| | | | |
|---|---|---|---|
| Regional function (AX22) | 0.4156 | 0.8355 | 0.3970 |
| Regional quality (AX23) | 0.3168 | 0.0539 | 0.3539 |
| | $f_{C1}$ | $f_{C2}$ | $f_{C3}$ |
| Regional asset growth rate (CX11) | 3.3037 | 3.2419 | 2.0807 |
| Regional GDP growth rate (CX12) | 3.2088 | 1.9589 | 1.7381 |
| Growth rate of regional per capita deposit (CX21) | 2.6453 | 3.1283 | 1.9469 |
| Regional per capita deposit and loan growth rate (CX22) | 2.5693 | 2.1416 | 1.6263 |
| | $f_{E1}$ | $f_{E2}$ | $f_{E3}$ |
| Regional foreign direct investment (EX11) | 1.2172 | 1.7481 | 0.7549 |
| Regional export economy (EX12) | 0.8444 | 1.2925 | 0.4887 |
| Regional import economy (EX21) | 0.5645 | 1.4991 | 0.8067 |
| Regional actual utilization of foreign capital (EX22) | 0.4621 | 1.5562 | 0.5223 |

Table 5 shows the internal relationship between the public factors $f_{A1}$, $f_{A2}$, $f_{A3}$, $f_{C1}$, $f_{C2}$, $f_{C3}$, $f_{E1}$, $f_{E2}$, $f_{E3}$ and the three indicators of regional scale (A), regional economic growth (C), and opening up (E), which has a significant impact on the degree of regional economic agglomeration. At this time, the evaluation index of regional economic growth effect is set, the score value of comprehensive factor is $F$, and the five indexes of regional economic growth effect are set, and the variance contribution rate of public factors are $\lambda_A$, $\lambda_B$, $\lambda_C$, $\lambda_D$ and $\lambda_E$ respectively. The ratio of variance contribution rate of public factors to cumulative variance contribution rate is taken as the weight, and the score value of each public factor is weighted sum. Then the comprehensive factor score of regional economic growth effect is:

$$F=\frac{\lambda_A}{\lambda_A+\lambda_B+\lambda_C+\lambda_D+\lambda_E}F_A+\frac{\lambda_B}{\lambda_A+\lambda_B+\lambda_C+\lambda_D+\lambda_E}F_B+\frac{\lambda_C}{\lambda_A+\lambda_B+\lambda_C+\lambda_D+\lambda_E}F_C+\frac{\lambda_D}{\lambda_A+\lambda_B+\lambda_C+\lambda_D+\lambda_E}F_D+\frac{\lambda_E}{\lambda_A+\lambda_B+\lambda_C+\lambda_D+\lambda_E}F_E \tag{6}$$

Through the calculation of formula (6), we can get the weight of the evaluation index of regional economic growth effect. According to formula (6), we can get the weight of each factor in the evaluation index of regional economic growth effect, that is, the factor load of the factor. Based on the above chapters, we can evaluate the effect of regional economic growth.

### 2.5 Evaluating the effect of regional economic growth based on Discrete Mathematics

To evaluate the effect of regional economic growth, discrete mathematics regards discrete mathematics as a network with $m$ nodes, which can be represented by Arabic numerals, i.e. $m = 1, 2, 3, \ldots m$. At this time, the evaluation indicators of regional economic growth effect can be brought in, that is, the target layer in Table 1 is regarded as a network, that is, the network of regional economic growth effect; its first level indicators include extension (ax1), connotation (AX2), economic concentration (BX1), economic diffusion (bx2), regional overall (CX1), per capita (CX2), economic aggregate (dx1), per capita distributive economy (DX2), export (EX1), import (ex2) When it can be regarded as a small network $i$ in the regional economic growth effect network, i.e. the first level indicator network, it can be expressed by Arabic numerals, i.e. $i = 1, 2, 3, \ldots m$. In the first level index, the second level index is regarded as the node $m$ contained in both networks. Because the rate of return between nodes changes with time, and when the regional economic benefits change in the rate of return between nodes, the regional economic benefits will also change, so there will be capital flow between nodes [15].

In practice, continuous variable time is always discretized. In order to consider the change rule of node yield and capital flow with time, $N$ is recorded as the set of all natural numbers. If $n$ is the time, then the economic yield of small network $i$ at $n$ is $r_i(n)$, the total capital of small network $i$ at $n$ is $A_i(n)$, $A_i^*$ is the initial economy of small network, and $A_{im}(n)$ is the initial economy of small network is the capital flow between $n$ small network $i$ and node $m$ at any time.

Obviously, for any $n \in N$, $i, m = 1, 2, \ldots, j$, there are:

$$A_i(n) = A_i^* + \sum_{k=1}^{n} \sum_{\substack{m=1 \\ m \neq 1}}^{j} A_{mi} \tag{7}$$

In formula (7), $k$ is the dimension of regional economic growth effect evaluation index network, and $j$ is constant. And when $A_{im}(n) > 0$ in formula (7), it means that funds flow from small network $i$ to node $m$ at $n$; when $A_{im}(n) < 0$, it means that funds flow from node $m$ to small network $i$ at $n$, and $A_{im}(n) = -A_{mi}(n)$ at this time.

The initial rate of return of small network $i$ is recorded as $r_i^*$, which means that when there is no capital flow between nodes, the rate of return of small network $i$ is $r_i(n)$ at $n$ time; the initial rate of return of node mm is recorded as $r_m^*$, which means that when there is no capital flow between nodes, the rate of return of node $m$ is $r_m(n)$ at $n$ time. Based on the evaluation index of regional economic growth effect established in this study, through the calculation process of evaluation index weight, it can be found that the cause of capital flow is the three-level index that can represent the public factor in the three-level index. After summary, it is found that there is a certain relationship with the economic income rate [16]. Therefore, when the basic rate of return difference between small network $i$ and node $m$, $r_i^* - r_m^*$ will not cause capital flow, and the economic rate of return difference $r_i(n) - r_m(n)$ at $n$ time is equal to the basic rate of return difference, instant, small network and node There will be no capital flow between them. The real reason for the capital flow is the difference of the variable of the return rate of each node, that is $r_i(n)-r_m(n)=r_i^*-r_m^*$, the difference of the weight of the regional economic growth effect evaluation index [17].

Let $R_i(n)$ denote the difference between the economic yield and the basic yield of the small network $i$ at $n$, that is $R_i(n)=r_i(n)-r_i^*$, and $R_i(n)$ is the relative yield of the small network; let $R_m(n)$ denote the difference between the economic yield and the basic yield of the node $m$ at $n$, that is $R_m(n)=r_m(n)-r_m^*$, and $R_m(n)$ is the relative yield of the node $m$. Therefore, if the size of $R_i(n)-R_m(n)$ is directly proportional to the amount of capital flow $A_{im}(n)$ of small network $i$ and node $m$ at $n$ time, and the proportion coefficient $K_{mi}>0$ generated at this time, there is the economic circulation rate between small network $i$ and node $m$:

$$R_i(n)-R_m(n)=R_{mi}A_{mi}(n) \tag{8}$$

In the criteria level of economic strength (d) in the regional economic growth effect evaluation index, the weight calculation results show that the faster the total amount of capital increases, the faster the change of the return rate at $n$ time. However, in the criteria level of regional economic growth effect evaluation index, the three criteria levels of regional scale (A), regional economic growth (C), and opening up (E) restrict the economic strength (D) Criteria layer, that is, the more funds other secondary indicator nodes invest in the small network, the lower the rate of return $r_i(n)$ at $n$ time, then there are:

$$\mathrm{V}r_i(n)=-c_i\mathrm{V}A_i(n-1) \tag{9}$$

In the formula(9), $c_i>0$ is the ratio coefficient between the total amount of capital $A_i(n)$ of small network $i$ at $n-1$ time and the economic return rate $r_i(n)$ at that time, reflecting the sensitivity of the real-time return rate of small network $i$ to economic change, that is, the sensitivity coefficient of small network $i$ [18]. At this time, V represents the forward difference operator, that is, $\mathrm{V}r(n)=r(n+1)-r(n)$, which is:

$$\mathrm{V}A_i(n-1)=\sum_{\substack{m=1\\ m\neq 1}}^{j}A_{mi}(n) \tag{10}$$

When (8) is brought into (10) and then (9), there is a system of regional economic change equations, that is, the discrete mathematical rate of return circulation equation:

$$r_i(n+1)-r_i(n)=c_i\sum_{\substack{m=1\\ m\neq 1}}^{j}\frac{1}{K_{mi}}\left\{\left[r_m(n)-r_m^*\right]-\left[r_i(n)-r_i^*\right]\right\} \tag{11}$$

But in the evaluation index of regional economic growth effect, in the criterion level of economic distribution (B), the change of economic growth is approximately equal. Therefore, if $r_i^*$ is constant and does not change with the change of small network $i$, there is a homogeneous rate of return circulation equation of discrete mathematics

$$r_i(n+1)-r_i(n)=c_i\sum_{\substack{m=1\\m\neq 1}}^{j}\frac{1}{K_{mi}}\left[r_m(n)-r_i(n)\right] \tag{12}$$

Formula (11) and formula (12) are two discrete mathematical equations, that is, the evaluation equation model of regional economic growth effect. Formula (11) can be used to evaluate regional economic growth change, and formula (12) can be used to evaluate regional homogeneous economic growth change. The overall reflection of the two equations is the regional economic growth effect. This paper studies the regional economic growth effect evaluation model, determines the evaluation index of the evaluation model, calculates the evaluation index weight of the evaluation model, and establishes the regional economic growth effect evaluation model to evaluate the regional economic growth effect.

## 3 Empirical analysis

In order to test the evaluation model of regional economic growth effect and evaluate the results of regional economic growth effect, empirical analysis is carried out. This empirical analysis selects a certain region in China to verify the regional economic growth effect evaluation model constructed by this study. As the regional economic growth effect is a comprehensive problem, the agglomeration of economic industries will have an impact on the regional economy, but the economic industry may be affected by the same macroeconomic factors, which makes the data have multiple collinearity. Therefore, the principal component analysis method of SPSS is used to determine the regional employment entropy $a$ and the economic output location entropy $b$ of the economic industry, and the two indicators are integrated, then there are the original data correlation matrix $Z$ of the two indicators in the region:

$$Z=\begin{bmatrix} & a & b \\ a & 1.000 & 0.973 \\ b & 0.973 & 1.000 \end{bmatrix} \tag{13}$$

In the matrix of formula (13), it can be seen that there is a strong direct correlation between the regional employment location entropy and economic output location entropy, and there is indeed information overlap. Therefore, the principal component analysis method of SPSS is used to calculate the variance contribution rate and cumulative contribution rate of the two indicators, and extract the principal components of the two indicators, as shown in Table 6.

**Table 6 Variance contribution rate, cumulative contribution rate and principal component coefficient of regional employment and economic output location entropy**

| Variance contribution rate, cumulative contribution rate | | | | | | Output component matrix |
|---|---|---|---|---|---|---|
| Component | Factor load | | | Common factor load | | Common factor load after rotation |
| | Characteristic value | Variance contribution rate | Cumulative variance contributio | Characteristic value | Variance contribution rate | Cumulative variance contributio |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | n rate | | | | n rate |
| Location entropy of regional employees | 1.937 | 98.644 | 98.644 | 1.973 | 98.644 | 98.644 | 0.993 |
| Location entropy of economic output value | 0.027 | 1.356 | 100.000 | | | | |

It can be seen from table 6 that only the first feature bit is greater than 1, so SPAA only extracts the first principal component, and the variance contribution rate of the first principal component reaches 98.644%, so the first principal component is selected to describe the regional economic distribution level. However, in the output principal component matrix in Table 9, the load of principal component on each variable can be indicated, and there are two standardized principal components $\beta_1$ and $\beta_2$:

$$T=0.993\beta_1+0.993\beta_2 \tag{14}$$

In the formula (14), $T$ is the comprehensive index of regional economic distribution. Because there are many indexes in the change of regional economic growth, the paper unifies the indexes of regional economic growth and verifies the regional growth effect evaluation model under the same index. Therefore, in addition to the economic distribution index, the economic growth rate $g$ of the region is selected to reflect the economic development index, but the economic growth rate $g$ index can reflect the economic growth more accurately without the influence of time trend. Therefore, the control variables selected in this empirical analysis include investment, technological progress, human capital, foreign trade, urbanization rate and education level, as shown in Table 7.

**Table 7 Statistics of variables in the region**

| Variable | Mean | Standard deviation | Maximum | Minimum value |
|---|---|---|---|---|
| Economic growth rate | 0.1461 | 0.0418 | 0.1482 | 0.2326 |
| Investment | 603.92 | 423.14 | 95.37 | 1332.64 |
| Human capital | 740.77 | 221.72 | 492.40 | 1179.70 |
| Foreign trade | 341.83 | 218.75 | 79.68 | 744.97 |
| Urbanization rate | 0.67 | 0.11 | 0.49 | 0.81 |
| Educational level | 8.06 | 4.69 | 2.20 | 15.78 |
| Technical progress | 22.46 | 20.67 | 3.91 | 69.13 |

Under the above parameters of this area, the evaluation model of this study is taken as group A of experiment, and the evaluation model in literature [4] and literature [5] mentioned in the introduction is taken as group B and group C of experiment respectively. Based on the evaluation characteristics of the regional economic growth effect evaluation model, this paper analyzes three groups of regional economic growth effect evaluation models from two aspects: the stability of the evaluation model for the regional economic growth effect and the change of the evaluation model for the regional economic growth effect, judges the stability of the evaluation indexes when the regional economic growth effect is evaluated, and evaluates the change of the regional economic growth effect. It is proved that the regional economic growth effect evaluation model of this study, whether the change of regional economic growth effect is consistent with the actual change, and whether the stability of each index variable is higher than the other two models in the evaluation process. In order to ensure the reliability and authenticity of the test results, 50 experiments were carried out, and the stability and spatial results of the regional economic growth effect evaluation were tabulated according to the experimental sequence, and the differences of different regional economic growth effect evaluation models were compared intuitively.

### 3.1 Stability comparison

Comparing the stability of the three groups of models is to evaluate the effect of regional economic growth through three groups of evaluation models. Under the given evaluation indexes, all variables in the model are in a stable state, especially when analyzing the effect of regional economic growth, it is required that the comprehensive index of economic growth rate and regional economic distribution is stable. As a result, there are errors in the evaluation results when the evaluation model evaluates the regional economic growth effect, which can not be used to analyze the regional economic growth effect. Therefore, unit root is used to test whether the index variables in the evaluation model are stable. Therefore, Eviews platform is selected to test the stability of the index variables in the evaluation model. The test results are shown in Table 8.

**Table 8 Inspection results of Eviews platform**

| Index variables of three experimental models | Eviews statistics | 5% threshold | Conclusion |
|---|---|---|---|
| Economic growth rate of group A | -3.559457 | -3.212696 | Stable |
| Economic growth rate of group B | 0.172896 | -3.11991 | Unstable |
| Economic growth rate of group C | -7.53451 | -4.10783 | Relatively stable |
| Comprehensive index of economic distribution in group A | -3.97834 | -3.46079 | Stable |
| Comprehensive index of economic distribution in group B | -6.123571 | -3.119910 | Relatively stable |
| Comprehensive index of economic distribution in group C | 1.43221 | -1.97098 | Unstable |

It can be seen from table 8 that the economic growth rate, Eviews statistics and 5% critical value of experimental group B are quite different and in an unstable state, while the comprehensive index of economic distribution, Eviews statistics and 5% critical value are slightly different and in a relatively stable state. The regression equation obtained by regression is a pseudo regression; the economic growth rate, Eviews statistics and 5% critical value of experimental group C are similar The difference between Eviews statistics and 5%

critical value is relatively stable, and the comprehensive index of economic distribution, Eviews statistics and 5% critical value are quite different, which is in an unstable state. The regression equation obtained by regression is a pseudo regression; while the comprehensive index of economic growth rate and economic distribution, Eviews statistics and 5% critical value of experimental group A are basically the same, and the regression equation obtained by regression, There is no pseudo regression. It can be seen that when group a evaluates the regional economic growth effect of the region, the evaluation index of the region has been in a stable state, which can verify the dynamic equilibrium relationship between variables and accurately evaluate the regional economic growth effect of the region.

### 3.2 Comparison of regional economic growth effects

Three groups of evaluation models are used to evaluate the changes of economic growth effect of the region in the past seven years under the above-mentioned evaluation indexes. The evaluation results of the three groups of models are compared with the actual economic growth changes of the region. In the given parameters, with the economic distribution index as the center, the economic growth rate, investment, technological progress, human capital, foreign trade, urbanization rate and education level evaluate the regional economic changes, forming the spatial agglomeration effect of FDI, so as to reflect the regional economic growth effect. The evaluation results are shown in Figure 1.

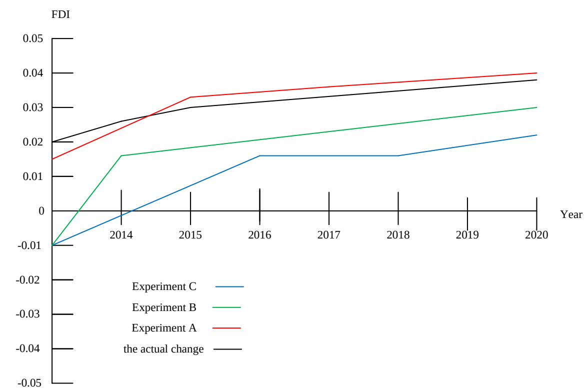


**Figure 1 Spatial agglomeration effect change of FDI**

It can be seen from Figure 1 that three groups of evaluation models evaluate the change of FDI agglomeration effect in the region in recent 7 years, and group A is the closest to the change of actual FDI agglomeration effect; while group B and group C also show the trend of growth, but between 2016 and 2018, group C has no change in FDI agglomeration effect; group B has a sharp growth in FDI agglomeration effect. After 2014, the growth is slow, which is consistent with the change of actual FDI agglomeration effect. It can be seen that the evaluation model of group A is more accurate and can be used to analyze the regional economic growth effect. Based on the above two experimental test results, we can see that the regional economic growth evaluation model of this study can accurately evaluate the regional economic growth effect, and in the evaluation process, we can judge the change of evaluation indicators in this region.

## 4 Conclusions

The evaluation model of regional economic growth effect in this study has given full play to the discrete characteristics of discrete mathematics, reduced the error of evaluation result caused by data difference, reflected the regional economic growth effect on the whole by using data, increased the evaluation accuracy of regional economic growth effect, considered the regional difference, designed the consistency test method, and increased the regional economic growth effect. The evaluation error of long-term effect should be controlled within the minimum range. However, the regional economic growth effect evaluation model of this study does not consider the impact of one regional economic growth effect on other regional economic growth. Therefore, in the future research, we should deeply study the economic growth effect of one region, the impact on other regions, and the regional economic growth effect driven by other regions.

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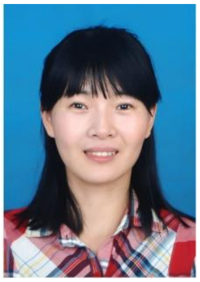

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