Team Number :	96234

Problem Chosen :	B

2019APMCM summary sheet

Contents

Analysis and Decision of Regional Economic Vitality and its Influencing Factors

ABSTRACT

The regional (or urban or provincial) economic vitality is an important part of regional comprehensive competitiveness. In recent years, in order to improve the economic vitality, some regions have launched many preferential policies for stimulating the economy vitality, In order to study how to improve the regional economic vitality, this paper takes Hunan province as an example to solve the problem.

For questions 1 and 3: In order to analyze and evaluate the urban economic vitality of Hunan province. This paper takes 14 urban areas in Hunan province in 2017 as the research objects, and studies the economic vitality of Hunan province in combination with the current economic development status of Hunan province.

First of all, selecting 12 indicators about six aspects from the yearbook of Hunan province, including the change of enterprise vitality ,the trend of population change, the openness of capital strength, the level of science and technology, and the comprehensive economic strength were selected to establish the index system of urban economic vitality. Through the factor analysis of the indicators by SPSS software, it is concluded that the main factors affecting the economic vitality are science and technology potential factor and Social production and foreign trade income factors, and the relationship between the indicators is established， and based on the relationship between the indicators the relationship model is established (the result is on the formula 5)。The influence of population change trend and enterprise activity change on economic activity is positively correlated.

Secondly, the relationship model is used to analyze the impact of population quality and quantity changes on regional economic vitality. the comprehensive factor analysis method was used to analyze and evaluate the urban economic vitality of each city and prefecture in Hunan in 2017. In order to quantify the influencing factors of economic vitality, this paper uses the component coefficient matrix to sum the scores of common factors by weighting, and takes the variance contribution rate as the weights to obtain the comprehensive evaluation model of economic vitality of each

region: $CEM = 0.49582 * f_1 + 0.47263 * f_2$, according to the calculation, the top five

cities in Hunan province in terms of economic vitality in 2017 are: Changsha Zhuzhou Yueyang Changde Xiangtan (The specific rankings are shown in table 7). In order to verify the rationality of this model, this paper USES this model to rank the economic vitality of each city and state in Hunan province from 2012 to 2017. The results obtained are roughly consistent with the statistical data of Hunan province, so this model has certain reliability.

Finally, based on the conclusions of the above model, in order to improve the

regional economic vitality, this paper puts forward that local governments should strengthen investment attraction, increase the number of enterprises in the region and introduce high-tech talents.

For question 2: in order to study the impact of economic policy transformation on a certain region, this paper takes chang-zhuzhou-xiangtan city group as an example to analyze the impact of economic policy transformation on this region from three perspectives. First of all, the existing data from 2012 to 2017 are used to predict the indicators after the economic policy transformation by using the cubic exponential smoothing method. Then, by comparing the forecast data with the existing data, it can be concluded that economic policy transformation can improve the vitality of enterprises, enhance the capital strength, and thus improve the economic vitality.

For question 4: combining with the conclusions of the question about one to three, from adjusting and optimizing industrial structure, strengthen the investment, strengthen industrial enterprise economic benefits, open to the public five aspects to provide some suggestion to help Hunan province each region's improve economic dynamism and sustainable development and the regional economic vitality

Key words: Factor Analysis, Economic Vitality, Comprehensive Evaluation Model of Economic Vitality, Cubic Exponential Smoothing

I   Problem Restatement

1.1 The background of this paper:

The regional (or urban or provincial) economic vitality is an important part of regional comprehensive competitiveness. In recent years, in order to improve the economic vitality, some regions have launched many preferential policies for stimulating the economy vitality, such as reducing the investment attraction approval steps, providing the capital support to start-ups and lowering the settlement threshold to attract the talented. However, due to different resource endowments, these policies have different effects in different regions. How to seize the key factors and effectively improve the regional economic vitality is a worth study topic.

1.2 The problems that need to be solved:

Problem 1: The regional (or urban or provincial) economic vitality is affected by variety of factors. Take a region (or city or province) as an example, please build the suitable relational model of influencing factors of economic vitality, and study the program of action to improve the regional economic vitality. Analyze the effects on the regional economic vitality change from the perspective of changing trend of population and enterprise vitality.

Problem 2: Select a region (or city or province), and analyze the short-term and long-term effects of economic policies transformation on the economic vitality of such region (or city ore province) based on the suitable data surveyed by you.

Problem 3: Measuring the regional economic vitality is a complex issue. Please select the suitable index system, establish the mathematical model which analyzes and measures the regional (or urban or provincial) economic vitality, and rank the economic vitality of cities in Attachment 3.

Problem 4: If you are a decision-maker of regional economic development, according to the conclusions for Problems 1-3, provide a development proposal for the region (or city or province) discussed in Problem 2 so that the economic vitality in this region presents the benign sustainable development and the regional competitiveness is stronger.

II   Problem Analysis

From the perspective of biology, "vitality" refers to the energy input and nutrient circulation capacity of the ecosystem, and specific indicators are the primary productivity and material circulation of the ecosystem. It represents vigorous vitality. The more frequent the input and output of energy in a system and the faster the material circulation, the higher the vitality of the system.

After referring to numerous literatures, this paper combines "vitality" with regional economy and gives an understanding of economic "vitality" : The economic "vitality" of a region is affected by various factors. "vitality" is not the simple addition of various elements in the region, it should be a certain structural characteristics and operating rules formed， which have the interrelation and interaction of various elements the overall function. The criterion to measure the "vitality" of a regional economy is whether the economic development of the region is healthy, lasting and stable.

According to the requirements in the paper, Hunan province is selected as the study area. It is because of Hunan province is located in central China, the middle reaches of the Yangtze river, located in the eastern coastal region and the central and western regions of the eastern coastal region and the transition zone of the central and western regions, the combination of the Yangtze open economic belt and the coastal open economic belt, with a hub position connecting the east and west, and the south and north.

2.1 Analysis of Problem 1:
First, the selection of indicators in this paper should follow the principles of systematicness, representativeness and data availability. In order to establish an appropriate relationship model of the influencing factors of economic vitality, several indicators were selected from the yearbook of Hunan province to construct the index system of urban economic vitality based on the six influencing factors of enterprise

vitality change, population change trend, openness, capital strength, science and technology level and comprehensive economic strength. SPSS software was used to conduct factor analysis on the indicators, quantify the relationship between the indicators, and establish the influencing factor model of economic "vitality"

Second, based on the influence of various indicators in the model on economic vitality, the existing action plan to improve economic vitality is studied, and based on this, the improvement is proposed.

Thirdly, by observing the correlation coefficient matrix of population change trend and enterprise vitality change, the influence of population change on economic vitality change is studied.

2.2 Analysis of Problem 2:

In order to study the impact of economic policy transformation on a certain region, take Chang‑Zhu‑Tan city group as an example to analyze the impact of economic policy transformation on this region. This paper studies the changes of economic vitality after the transformation from three aspects: openness, capital strength and enterprise vitality. The three-order exponential smoothing model is used to predict the index data after the transformation. By analyzing the difference between the forecast data and the actual data, we can get the influence of economic policy transformation on Chang‑ZhuTan area.

2.3 Analysis of Problem 3:

This question is required to establish a mathematical model to analyze and measure the regional economic vitality，and ranked the urban economic vitality. According to the index system established in question 1, a comprehensive evaluation model of economic vitality based on principal component analysis and factor analysis can be established to obtain the score of economic vitality of each city and rank it.

2.4 Analysis of Problem 4:

As the decision-maker, in order to make the economic vitality of changzhutan area present a benign and sustainable development, we should adjust the policy from the following five aspects: adjusting and optimizing the industrial structure, strengthening the investment, enhancing the economic benefit of industrial enterprises, and opening to the outside world

III   Model Assumption

1. It is assumed that no major natural disasters affect the economic vitality growth of a city in Hunan province
2. It is assumed that every city develops dynamically and is influenced by a series of mutually restrictive factors
3. It is assumed that all urban economies show a healthy growth trend with reasonable internal structure

IV   Symbol Description

F_i	represents the score of the ith factor
$X = [x_1 \ldots \ldots x_{12}]$	x_i is the value of the ith index
α	the data smoothing factor，$0 < \alpha < 1$;
β	the trend smoothing factor，$0 < \beta < 1$;
γ	the seasonal smoothing factor, $0 < \gamma < 1$

Note: part of the explanation is shown in the text

V   The Establishment and Solution of the Model

5.1 Solution of Problem 1:

5.1.1 Modeling:

In order to study the influence factors of economic vitality in Hunan province, this paper selected 12 economic development indicators of 14 municipal cities in Hunan province. Noted that the measurement scale of each variable is not uniform, including quantity unit, dollar, RMB, ratio, etc., so before the analysis, it is necessary to consider standardizing the variable, or using correlation matrix to calculate the common factor. Through factor analysis of these 13 variables, this paper hopes to discover some common factors behind them that are not easy to observe but can properly measure and explain the level of economic development.

(1) Selection of Economic Vitality Measurement Indicators

In accordance with the principles of selection of indexes, by means of various cities in the calendar year local statistical yearbook collection of related original indexes is analyzed, and consider the consistency and continuity of indicators statistical caliber, we in the dynamic changes of enterprises, the population change trend, degree of openness, financial strength, technology level and comprehensive economic strength of six aspects chose the original index the index evaluation system of urban vitality .Considering the comparability of different cities, these indicators are all based on per capita or relative weighting .

The change of enterprise vitality mainly consists of the number of enterprises, the number of new enterprises and the gross domestic product of the region:

The degree of openness can reflect a city's attraction to urban areas and its diffusion and radiation. To build a market economy and participate in regional

competition requires a highly open and competitive market system. Therefore, the openness and externality of a city are an important component of its vitality. Including indicators are: total import and export, total foreign trade.

Capital strength can indicate the status and function of capital elements indispensable in the process of wealth production and creation. The investment and accumulation of capital is the direct cause of economic growth, which is also one of the factors of urban development and progress. Including indicators are: total resident fixed capital, regional fixed asset investment;

The level of science and technology is the main source of economic growth. The application of science and technology goes deep into all aspects of economic life and has a profound impact on society. Included indicators are: the situation of R&D personnel, research institutions, all the R&D projects;

The comprehensive economic strength can reflect the level and stage of a city's economic development. Including indicators are: per capita gross domestic product, total output.

The above index system can be represented by table 1

Table 1   Index System of Economic Vitality

	The First Indicators	The Secondary Indicators	unit	
Economic Vitality	Changes in Enterprise Vitality	Number of the Enterprises	unit	X1
		Number of the New Enterprises Added	unit	X2
		GDP	100 million yuan	X3
	Demographic Trend	Average Population	10 thousand	X4
	Openness	Total Import-Export Value	10 thousand dollar	X5
		Foreign trade and Tourism	100 million yuan	X6
	Comprehensive Economic Strength	Gross Output	100 million yuan	X7
		Regional Fixed Assets	100 million	X8

		yuan	
	GDP Per Capita	yuan	X9
	R&D Personnel	person	X10
Scientific and Technological Level	Statistice on Scientific Research Institutions	unit	X11
	Statistics on Total R&D Projects	item	X12

The statistical yearbook of Hunan from 2012 to 2017 was used to collect the data of related indicators in the above table of 14 cities.

(2) Establishment of Factor Analysis Model:

The factor score is calculated by multiplying the component score coefficient matrix by the standardized index：

$$F_i = \alpha_{i1}x_1 + \alpha_{i2}x_2 + \cdots + \alpha_{ip}x_p \ (p = 1, 2, \ldots m) \tag{1}$$

F_i represents the score of the ith factor；$x_1, \ x_2, \ldots x_p$ represents the normalized

value of the index；$\alpha_{i1}, \alpha_{i2}, \ldots \alpha_{ip}$ represents the component score coefficient，The

total factor score is equal to the weighted arithmetic mean of each factor score.

$$F = \sum b_i F_i \ \left(\sum b_i = 1 \right) \tag{2}$$

F represents the score of the total factors, B is the contribution of the ith factor,(Molecular contribution = variance contribution rate after molecular rotation/total variance interpretation rate)

5.1.2 Model Solution:

This paper selects 13 indicators to calculate the comprehensive indicators of economic vitality. Since there are many indicators in this paper, the low correlation of some indicators may cause the KMO value to be too low. Therefore, KMO and Bartlett tests are conducted on the data in advance.

Table 2   KMO and Bartlett's test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.757
Bartlett's Test of Sphericity	Approx. Chi-Square	388.868
	df	66
	Sig.	.000

According to the data in the table, it can be seen from the results of Bartlett's spherical hypothesis test that, at the significance level of 1%, p is 0.0000 and the spherical null hypothesis is rejected, so the 13 indicators are not independent and suitable for factor analysis. It can be seen from table 3 that the KMO value is 0.757, greater than 0.7, so it is considered that the sample can be analyzed by factor

Table 3   Communalities

Communalities

	Initial	Extraction
Number of the Enterprises(unit)	1.000	.990
Number of the New Enterprises Added(unit)	1.000	.988
GDP(100 million yuan)	1.000	.987
Floating Population in Central City(10 thousand)	1.000	.894
Total Import-Export Value (10 thousand dollar)	1.000	.946
Foreign trade and Tourism（100 million yuan)	1.000	.989
Gross Output（100 million yuan)	1.000	.993
Regional Fixed Assets （100 million yuan)	1.000	.980
R&D Personnel（person)	1.000	.989
Statistice on Scientific Research Institutions （unit)	1.000	.977
Statistics on Total R&D Projects（item)	1.000	.971
GDP Per Capita（yuan)	1.000	.918

Extraction Method: Principal Component Analysis.

The larger the variance of extracted common factors among variables, the stronger the ability to be interpreted by common factors. and the degree of interpretation of all variable factors proposed by extracted common factor variance is higher than 90%. Therefore, the extraction effect is better and the loss of original data is less. Generally speaking, for variance contribution rate not less than 90%, factor extraction component interpretation information accounts for 90% of the total information. For factors with feature root greater than 1, SPSS software was used for data analysis, and two factors were finally obtained, as shown in table 4 below:

Table 4   Total variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.364	94.699	94.699	11.364	94.699	94.699	5.950	49.582	49.582
2	.258	2.146	96.845	.258	2.146	96.845	5.672	47.263	96.845
3	.155	1.289	98.134						
4	.130	1.083	99.217						
5	.043	.358	99.575						
6	.028	.235	99.810						
7	.009	.072	99.883						
8	.007	.057	99.940						
9	.005	.042	99.982						
10	.002	.014	99.996						
11	.000	.003	99.999						
12	.000	.001	100.000						

Extraction Method: Principal Component Analysis.

It can be seen from table 4 that the cumulative variance contribution rate reached 96.845%, indicating that the first two factors contained 96.845% of all indicator information, and the extracted information amount was relatively large. Therefore, it can be seen that the effectiveness of factor analysis in extracting original variable information was relatively high.

It can also be seen from the lithotripsy chart that the information contributed by the first two factors represents that the polyline is relatively steep, while the subsequent polyline is relatively gentle, so it is reasonable to extract the two factors.
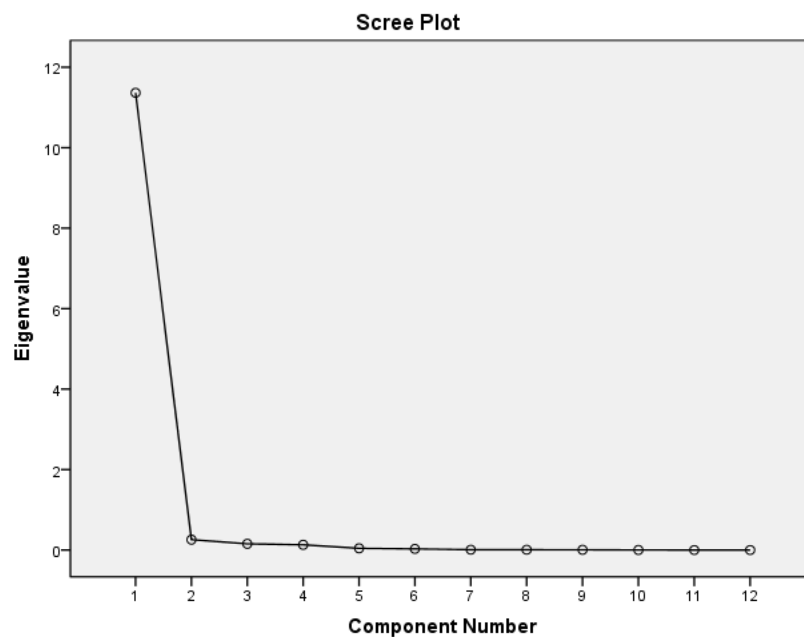
Table 5   Rotated Component Matrix

Rotated Component Matrix^a

	Component	
	1	2
GDP Per Capita（yuan)	.843	.466
Average Population(10 thousand)	.807	.516
Statistics on Total R&D Projects（item)	.796	.571
R&D Personnel（person)	.765	.634
Gross Output（100 million yuan)	.710	.699
Statistice on Scientific Research Institutions（unit)	.706	.686
Number of the New Enterprises Added(unit)	.487	.866
Number of the Enterprises(unit)	.517	.847
Regional Fixed Assets（100 million yuan)	.634	.760
GDP(100 million yuan)	.689	.715
Foreign trade and Tourism（100 million yuan)	.697	.711
Total Import-Export Value (10 thousand dollar)	.671	.707

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

The data in the rotating component matrix table (table 5) indicate that the main driving factors of economic vitality can be divided into technology potential factor and Social production and foreign trade income factors

Technology potential factor：The potential of science and technology is an important manifestation of economic vitality. Through technological innovation, production can be promoted to avoid being eliminated. Only by continuously producing products and services to meet the market demand can the economic benefits of industrial enterprises be improved, thus promoting the economic growth of the region. GDP per capita、average population、Statistics on Total R&D Projects、R&D personnel、Statistice on scientific Research institutions 、Gross output can be used to evaluate the technology potential

Social production and foreign trade income factors: the level of regional enterprise vitality can reflect the level of economic development. The vitality of enterprises is mainly evaluated by Foreign trade and Tourism, Total import-export Value, The number of new business added, The number of The enterprise, Regional Fixed Assets and GDP. The increase in the number of enterprises can rapidly expand the employment area and jobs, avoid labor surplus, raise people's income and stimulate people's consumption.

To obtain the expression of the factor, the component coefficient matrix A is obtained from the component coefficient matrix table:

Table 6   Component Score Coefficient Matrix

Component Score Coefficient Matrix

	Component	
	1	2
Number of the Enterprises(unit)	-.539	.668
Number of the New Enterprises Added(unit)	-.623	.752
GDP(100 million yuan)	-.002	.127
Average Population(10 thousand)	.552	-.443
Total Import-Export Value (10 thousand dollar)	-.021	.144
Foreign trade and Tourism（100 million yuan)	.018	.107
Gross Output（100 million yuan)	.064	.060
Regional Fixed Assets （100 million yuan)	-.177	.304
R&D Personnel（person)	.273	-.153
Statistice on Scientific Research Institutions （unit)	.078	.044
Statistics on Total R&D Projects（item)	.438	-.324
GDP Per Capita（yuan)	.704	-.598

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Component Scores.

The composition coefficient matrix is obtained from the above table

$$A = \begin{pmatrix} -0.54 & -0.62 & -0.002 & 0.55 & -0.021 & 0.02 & 0.06 & -0.18 & 0.27 & 0.08 & 0.44 & 0.70 \\ 0.67 & 0.75 & 0.13 & -0.44 & 0.14 & 0.11 & 0.06 & 0.3 & -0.15 & 0.04 & -0.32 & -0.59 \end{pmatrix}$$

Based on the component coefficient matrix, the relationship model of influencing factors of economic vitality as shown in equation (3) can be established:

$$F = A^T X^T \tag{3}$$

Where $X = [x_1 \ldots \ldots x_{12}], x_i$ is the value of the ith index; $F = [f_1, f_2], f_i$ represents the score of the ith factor.

It can be seen from table 4 that the variance contribution rate of science and technology potential factors is greater than that of social production and foreign trade income factors, which means that the former contributes more to the economic vitality. Therefore, to improve the urban economic vitality, investment in science and technology research should be increased to improve the level of science and technology development. However, the development of science and technology cannot be accomplished overnight, which requires strong support from the government and continuous capital investment. Education should be vigorously developed to cultivate high-tech talents, develop high-tech industries, and attract well-known scholars at home and abroad. In addition, the government should macro-control the market, improve employment rate, and increase the total output value of the region. However, due to the uncertainty of the market and the impact of international environment and other factors, social production and foreign trade

income factors cannot be fully engaged in, but can also be regarded as an auxiliary means to improve economic vitality.

According to the indicator system established above and table 5, it can be seen that the influencing factors of the change of enterprise vitality and population change trend are: number of enterprises, number of new enterprises, GDP and average population, respectively. The influence coefficients of each factor on the potential factor of science and technology were: -0.539, -0.623, -0.002,0.552. The influence coefficients on social production and foreign trade revenue factors are: 0.668,0.752,0.127, -0.443.

From the perspective of the change of enterprise vitality, it can be seen that the average population has a positive correlation with the impact of science and technology potential factors, while the number of enterprises, the number of new enterprises and GDP have a negative correlation with the impact of science and technology potential factors. From the perspective of population change trend, it can be seen that the number of enterprises, the number of new enterprises and GDP have a positive correlation with the impact of foreign trade revenue factors. The influence of average population on foreign trade revenue factor is negatively correlated.

5.2 Solution of Problem 2:

Because the change of each index with time does not have linear and nonlinear function relation, and the index number is listed as time series. Therefore, this paper USES the cubic exponential smoothing method to build the time series model of each index through debugging the weighted coefficient coefficients and the initial value $S_0^{(1)}$), and obtains the predicted value scores of each index.

5.2.1 The Establishment and Solution of the Model:

Cubic exponential smoothing is a further smoothing on the basis of quadratic exponential smoothing, and its calculation formula is as follows:

$$\begin{cases} S_t^{(1)} = \alpha y_t + (1-\alpha)S_{t-1}^{(1)} \\ S_t^{(2)} = \alpha S_t^{(1)} + (1-\alpha)S_{t-1}^{(2)} \\ S_t^{(3)} = \alpha S_t^{(2)} + (1-\alpha)S_{t-1}^{(3)} \end{cases}$$

Note: $S_t^{(3)}$ is a cubic exponential smoothing value

The prediction model of cubic exponential smoothing method is

$$\widehat{y_{t+m}} = a_t + b_t m + C_t m^2 , m = 1,2, \dots \dots$$

$$\begin{cases} a_t = 3S_t^{(1)} - 3S_t^{(2)} - S_t^{(3)} \\ b_t = \dfrac{\alpha}{2(1-\alpha)^2}\left[(6-5\alpha)S_t^{(1)} - 2(5-4\alpha)S_t^{(2)} + (4-3\alpha)S_t^{(3)}\right] \\ c_t = \dfrac{\alpha^2}{2(1-\alpha)^2}\left[S_t^{(1)} - 2S_t^{(2)} + S_t^{(3)}\right] \end{cases}$$

Since the trend of daily sales of goods is cumulative, the cumulative formula is as follows

$$s_0 = x_0$$

$$s_t = \alpha(x_0 - c_{t-L}) + (1-\alpha)(s_{t-1} + b_{t-1})$$

$$b_t = \beta(s_t - s_{t-1}) + (1-\beta)b_{t-1}$$

$$c_t = \gamma(x_t - s_{t-1} - b_{t-1}) + (1-\gamma)c_{t-L}$$

Where α is the data smoothing factor, $0 < \alpha < 1$; β is the trend smoothing factor, $0 < \beta < 1$; γ is the seasonal smoothing factor, $0 < \gamma < 1$. After multiple tests, for this problem, take $\alpha = 0.3$, $\beta = 0.3$, $\gamma = 0.5$.

Using MATLAB programming(See appendix 1 for the code), under the assumption that economic policies do not transform, we can obtain the short-term predicted economic vitality scores of various indicators of Chang-Zhuzhou-Xiangtan city group, as shown in the table below:

Table 7 The Short-term Predicted Economic Vitality Scores of Various Indicators of Chang-Zhuzhou-Xiangtan City Group

	FAC1_2	FAC2_2	score_open_short
Degree ofopenness	3.95799	0.92817	2.3761
Capital or Cash	0.39459	4.47675	2.3002
scientific and technological level	3.82312	0.7989	2.2906

Similarly, a cubic exponential smoothing model was used to predict the long-term economic vitality score, and the long-term economic vitality score of each index was obtained as shown in the table below:

Table 8 The Long-term Economic Vitality Score of Each Index

	FAC1_3	FAC2_3	score_open_long
Degree ofopenness	4.45762	0.38909	2.3909
Capital or Cash	0.31576	4.61764	2.3058
scientific and technological level	4.77338	5.00673	4.6967

However, in reality, after the transformation of economic policies, the comprehensive score of economic vitality of Chang-Zhuzhou-Xiangtan city group can be shown in the following table:

**Table 9   The Comprehensive
Score of Economic Vitality of Chang-Zhu-Tan City Group**

	FAC1_1	FAC2_1	score_normal
Degree ofopenness	3.93064	0.70988	2.2807
Capital or Cash	3.93064	0.70988	2.2807
scientific and technological level	3.93064	0.70988	2.2807

Finally, the comprehensive effects of the three indicators on economic vitality are obtained, as shown in the table

**Table 10   The Comprehensive
Effects of the Three Indicators on Economic Vitality**

score_normal	score_short	score_long
2.2807	2.3429	2.3909

As can be seen from the above tables, the economic policy transformation can better promote the economic vitality of the Chang-Zhuzhou-Xiangtan city group, but the same economic transformation policy can only greatly improve the economic vitality in a short period of time. In the long run, the same economic transformation policy does not increase economic vitality as significantly as the short term. Therefore, in order to better promote economic vitality, local governments should proceed from the actual situation and adjust economic policies in a timely manner.

5.3 Solution of Problem 3:

5.3.1 Problem Analysis:

In order to analyze and measure the economic vitality of each city and state in Hunan province, this paper also investigates the comprehensive vitality of each city and state. The scores of the two common factors in the above paper were weighted and summed, and the variance contribution rate was taken as the weight. It can be seen from table 4 that the variance contribution rate of the two rotated factors was 49.582% and 47.263% respectively, so the comprehensive evaluation model of economic vitality of each region was obtained:

$$CEM = 0.49582 * f_1 + 0.47263 * f_2 \qquad (4)$$

The comprehensive scores of each region were calculated through the economic vitality evaluation model. The following is the economic vitality ranking of each city and state in Hunan province:

Table 11   Economic Vitality Table of Hunan Province

city	score	rank
Changsha	2.37	1
Zhuzhou	0.07	2
Xiangtan	0.06	3
Hengyang	0.03	4
Shaoyang	0.02	5
Yueyang	−0.02	6
Changde	−0.05	7
Zhangjiajie	−0.21	8
Yiyang	−0.21	9
Chenzhou	−0.23	10
Yongzhou	−0.35	11
Huaihua	−0.4	12
Loudi	−0.54	13
West Hunan	−0.57	14

As can be seen from the economic vitality scores of cities and states in Hunan province in the above table, the top five cities in economic vitality of Hunan province are :Changsha Zhuzhou, Yueyang, Changde, Xiangta. The results are consistent with the statistical survey data of Hunan province, so the model is reliable. 5.3.2 Model generalization.

5.3.2 Model Generalization

(1) Based on the comprehensive evaluation model of economic vitality established in this paper, the analysis of economic "vitality" of each city in Hunan province is as follows:

First of all, the comprehensive evaluation ranking of cities and states in Hunan province from 2012 to 2017 is given.

Table 12   2012-2017 Comprehensive Evaluation Ranking of Cities and States in Hunan Province

City	2012		2013		2014		2015		2016		2017	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Changsha	2.37	1	2.330269	1	2.41	1	2.39	1	2.36	1	2.37	1
Zhuzhou	0.1	2	0.142436	2	0.08	2	0.1	3	0.07	2	0.07	3
Xiangtan	0.1	6	0.067525	6	0.03	3	0.08	4	−0.06	3	0.06	7
Hengyang	0.03	3	0.046204	5	−0.04	4	0.04	5	0.09	4	0.03	2
Shaoyang	0.03	11	0.00974	10	−0.36	5	0.02	10	−0.22	5	0.02	8
Yueyang	0.03	5	−0.00212	3	0.13	6	0	2	0.06	6	−0.02	4
Changde	−0.04	7	−0.02007	7	0.03	7	−0.06	6	0.01	7	−0.05	5
Zhangjiajie	−0.27	14	−0.24521	13	−0.5	8	−0.22	13	−0.54	8	−0.21	13
Yiyang	−0.27	8	−0.2645	8	−0.2	9	−0.27	8	−0.23	9	−0.21	10
Chenzhou	−0.28	4	−0.26944	4	−0.05	10	−0.33	7	−0.01	10	−0.23	6
Yongzhou	−0.33	10	−0.29714	9	−0.25	11	−0.33	9	−0.23	11	−0.35	9
Huaihua	−0.39	12	−0.3995	12	−0.4	12	−0.4	12	−0.41	12	−0.4	12
Loudi	−0.53	9	−0.54431	11	−0.32	13	−0.49	11	−0.32	13	−0.54	11
Xiangxi	−0.54	13	−0.5539	14	−0.55	14	−0.53	14	−0.57	14	−0.57	14

From the comprehensive evaluation results, it can be seen that from 2012 to 2017, the comprehensive ranking of the Chang-Zhuzhou-Xiangtan city cluster was relatively high, while the ranking of Huaihua, loudi and xiangxi was relatively low.

(2) According to the above research results, the scientific and technological potential factor (factor 1) score ranking of each city's economic vitality in Hunan province from 2012 to 2017 is as follows:

Table 13   Score Ranking of Technological Potential Factor

City	2012		2013		2014		2015		2016		2017	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Changsha	2.73152	1	2.604782	1	2.90657	1	2.8182	1	1.85631	1	2.70061	1
Zhuzhou	0.22856	5	0.376317	4	-0.15079	7	-0.04847	7	0.44049	6	-0.11167	6
Xiangtan	0.88167	2	0.994678	2	0.52531	3	0.96088	2	-1.19257	12	1.3417	2
Hengyang	-0.17253	9	-0.40384	9	-0.93596	13	-0.7309	13	0.72308	3	-0.313	10
Shaoyang	-0.46231	10	-0.47593	10	-1.39629	14	-1.58819	14	0.52812	4	-1.50251	14
Yueyang	-0.82496	11	-0.70081	11	0.63441	2	0.40858	3	0.42746	7	-0.01273	5
Changde	-1.08082	13	-1.16113	13	0.18148	4	0.04594	5	0.87077	2	-0.54904	11
Zhangjiajie	-0.02586	7	-0.10666	7	-0.01409	6	0.13558	4	-1.55476	13	0.40065	3
Yiyang	-1.15191	14	-1.18656	14	0.15546	5	-0.03763	6	0.1445	9	-0.18657	7
Chenzhou	0.33289	4	0.753451	3	-0.77644	12	-0.47201	11	0.47372	5	-0.72347	13
Yongzhou	-0.98978	12	-0.88889	12	-0.22874	9	-0.60274	12	0.18076	8	-0.60054	12
Huaihua	-0.06661	8	-0.13042	8	-0.1648	8	-0.31725	9	-0.81268	11	-0.25743	8
Loudi	0.38502	3	0.226679	5	-0.28294	10	-0.42087	10	-0.4658	10	-0.28539	9
Xiangxi	0.2151	6	0.098329	6	-0.45318	11	-0.15112	8	-1.61941	14	0.09938	4

As can be seen from the table, Changsha has consistently ranked first in terms of its scientific and technological potential factor over the years in the whole province, Xiangtan and other cities ranked relatively high in the whole province, while Yongzhou, West Hunan and other regions scored relatively low. It can be judged from this, Changsha and other areas to science and technology vitality is higher.

(3) The scores and rankings of social production and foreign trade income factors of various cities in Hunan province from 2012 to 2016 are as follows:

Table 14   Social Production and Foreign Trade Revenue Factor Score Ranking

City	2012		2013		2014		2015		2016		2017	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Changsha	1.88351	1	2.031885	1	1.58937	1	1.74931	1	2.82538	1	1.96934	1
Zhuzhou	-0.05527	7	-0.11178	8	0.4652	5	0.2626	5	-0.29988	7	0.23828	6
Xiangtan	-0.9716	11	-1.08559	13	-0.78355	11	-1.33892	13	1.10408	2	-1.49774	14
Hengyang	0.41197	6	0.459281	5	1.45449	2	1.14581	3	-0.55411	10	0.47226	5
Shaoyang	-0.17075	8	-0.04499	7	1.36211	3	1.5611	2	-0.97683	14	1.1506	2
Yueyang	1.02987	3	0.902672	3	-0.71672	9	-0.36773	9	-0.3262	8	0.07875	8
Changde	1.17132	2	1.220213	2	-0.23175	6	-0.05801	7	-0.87503	13	0.61393	4
Zhangjiajie	-1.1284	13	-1.02	12	-1.30661	14	-1.42656	14	0.50582	3	-1.50043	13
Yiyang	0.77399	4	0.778002	4	-0.80173	13	-0.48764	10	-0.60316	11	-0.26065	9
Chenzhou	-0.31801	9	-0.72254	10	1.16889	4	0.56885	4	-0.50139	9	0.72006	3
Yongzhou	0.5606	5	0.414181	6	-0.29807	7	0.23103	6	-0.64861	12	0.20385	7
Huaihua	-0.7649	10	-0.69198	9	-0.79185	12	-0.53432	11	0.00802	5	-0.53252	11
Loudi	-1.02791	12	-0.8665	11	-0.38572	8	-0.20425	8	-0.16426	6	-0.40473	10
Xiangxi	-1.39442	14	-1.26285	14	-0.72407	10	-1.10124	12	0.50617	4	-1.25102	12

As can be seen from the table, Changsha's score of social production and foreign trade income factors is still in the forefront in Hunan province, while zhangjiajie, xiangxi and other regions are in the rear.

To sum up, whether a city has economic vitality can be judged from social production and foreign trade income factors and scientific and technological potential. Using Excel to draw the broken line chart of the regional comprehensive score, it can be seen from the figure * that the economic vitality of Changsha ranks the first in all the years and far exceeds that of other cities, which is closely related to Changsha's

policy of vigorously developing tourism and actively introducing high-tech talents. The overall score of economic vitality of other cities was between [-0.5,0.5], far lower than that of Changsha. However, the comprehensive economic vitality ranking of Hunan cities is relatively stable, so other regional governments should actively play their administrative functions, strengthen the efforts of opening to the outside world, and actively introduce high-tech talents and technologies to mobilize the regional economic vitality.
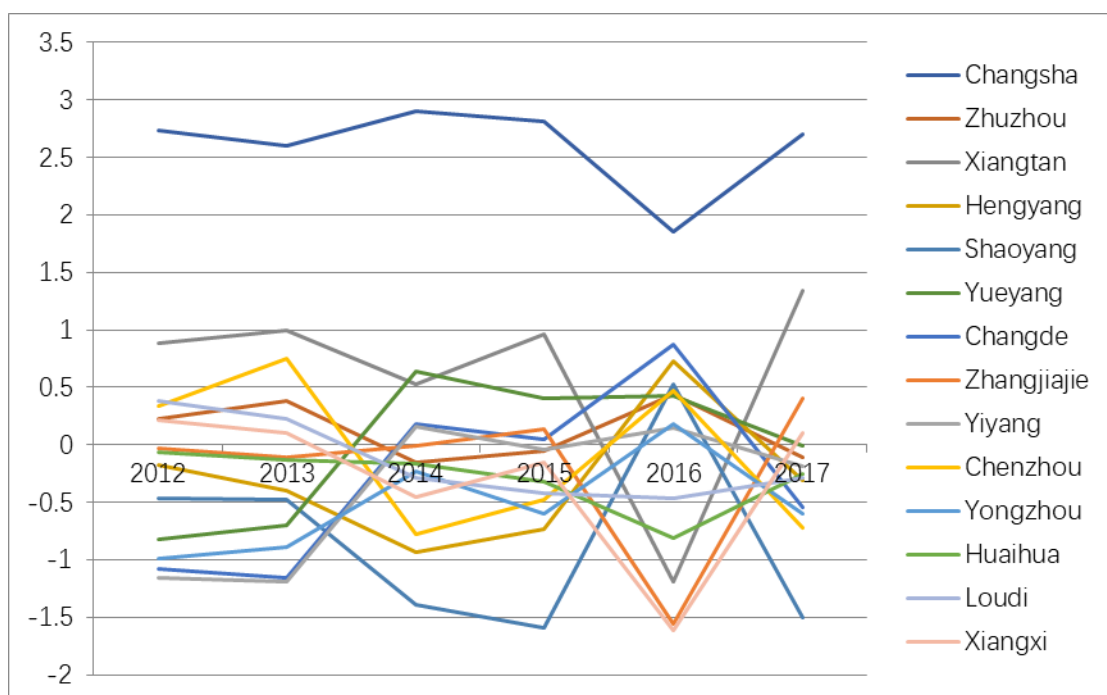
Chart 1   Technology Potential Score Line Chart
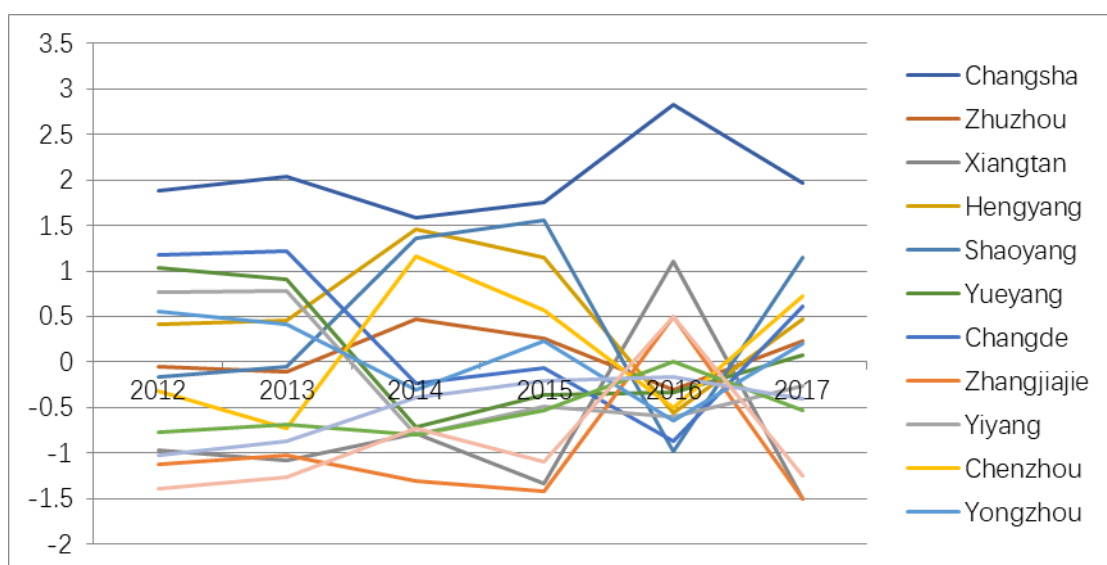
Chart 2   Social Production and Foreign Trade Income Line Chart
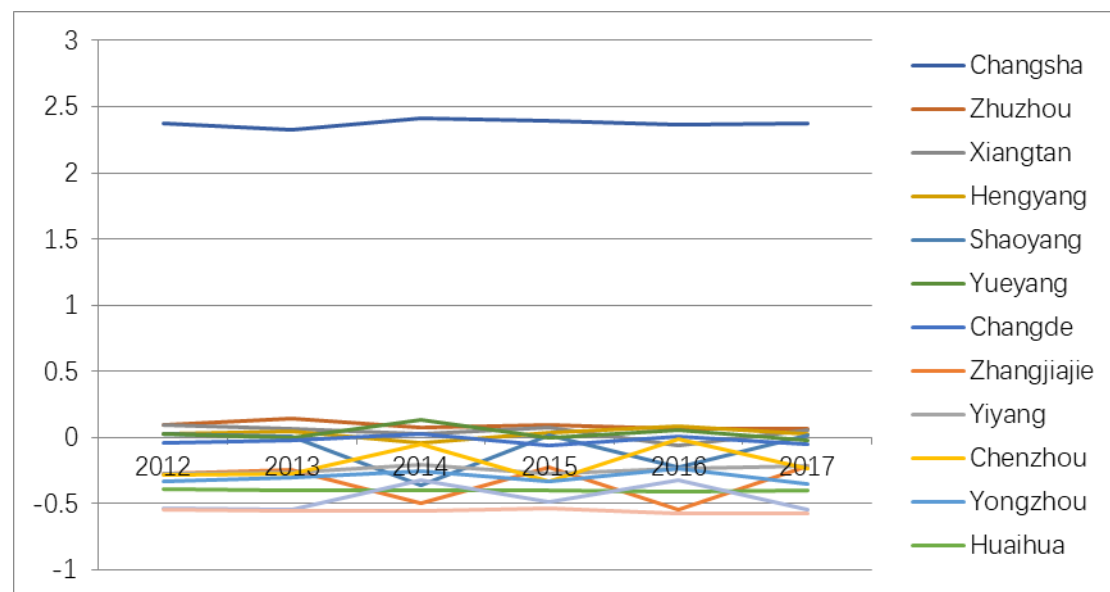
Chart 3   Comprehensive Score of Economic Vitality Line Chart

5.4 Solution of Problem 4:

From question 1 to question 3, as the decision-maker of regional economic development, in order to make the economic vitality of Hunan province present a sound sustainable development and stronger regional competitiveness, the author believes that we should adjust the policy from the following four aspects: adjusting and optimizing the industrial structure, strengthening investment, enhancing economic benefits of industrial enterprises, and opening to the outside world.

5.4.1 Adjusting and Optimizing the Industrial Structure

(1) Vigorously Develop the Tertiary Industry

The tertiary industry is an important symbol of a country's economic development. Compared with the primary industry and the secondary industry, the tertiary industry has the characteristics of less investment, short cycle, quick effect, and higher salary income of employed personnel. The active development of the tertiary industry can not only strengthen the overall quality culture in the region, but also promote the transformation from agricultural society to industrial society and improve agricultural productivity. On the other hand, vigorously developing the tertiary industry can rapidly expand the employment field and jobs, avoid labor surplus, and improve the income of residents; Secondly, in modern cities, residents not only have material needs, but also pursue spiritual ones. This development trend promotes the continuous development of new industries to meet people's needs, thus significantly improving people's living standards and quality of life. Taking Chang-Zhu-Tan city group as the center, we should actively accelerate the development of the tertiary industry and promote the surrounding cities.

5.4.2 Strengthening Investment

Investment is a component element of economic vitality, and the increase of investment intensity is of great significance to the promotion of economic vitality. In China, investment is divided into government investment, private investment and foreign investment. Reasonable government investment will promote the development of the public sphere, strengthen the construction of urban public infrastructure, and allow residents to enjoy more additional benefits. However, unreasonable government investment may cause the waste of resources or the shortage of resources, resulting in unbalanced social and economic development. The regional governments of Hunan province should grasp the scope of investment, improve efficiency, focus on the public sector and the areas that must be monopolized by the government, and try to avoid direct interference in other industries, affecting private investment and foreign investment.

While rationally regulating government investment, private and foreign investment should be actively encouraged. In the context of China's market economy, the economic benefits of private investment are the basis for sustainable economic development. The government and private investment should cooperate and exchange, encourage and support technological innovation, develop high-tech industries, emerging industries, support small and medium-sized enterprises, and enhance the growth of the economy.

5.4.3 Improve the Economic Performance of Industrial Enterprises

(1) Enhance the Capacity for Technological Innovation

Under the background of China's market economy, it is of great significance for industrial enterprises to enhance their technological innovation ability to improve their economic benefits. The use of technological innovation to promote production, to avoid being eliminated backward, we can only continue to produce products and services to meet market demand, to improve the economic benefits of industrial enterprises, so as to promote the economic growth of the region, to promote industrial development. Industrial enterprises shall organize technology exchange meetings on a regular basis to introduce advanced technology and experience and enhance their capacity for technological innovation.

(2) Igorously Develop New and High Technology Industries

Under the environment of green development in China, only by vigorously developing the high-tech industry can the proportion of the high-tech industry in the industrial industry continue to rise. Its advantages are high output, low consumption of energy and good efficiency, which not only avoids the waste of resources, but also realizes the development of new industrialization and directly improves the economic benefits of industrial enterprises. In addition, the development of high-tech industry also affects the industrial system in the study and application of other traditional industries, thereby giving impetus to the industrial enterprise of high and new technology in traditional penetration and development of the indirect strengthening

science and technology content of the traditional industry, make the whole industrial enterprise the levels of science and technology of the industry, so as to realize the growth of industrial enterprise economic benefits.

(3) Increase Funding for Science and Technology and Researchers

Increasing scientific and technological funds and scientific researchers' input is the basis and premise of vigorously developing high-tech industries and strengthening technological innovation capacity. The local government and enterprises should realize the importance of scientific research funds and scientific research personnel, increase investment in scientific research at the same time, also want to actively carry out technical innovation activities, attract high-tech talent, talent introduction mechanism, talent cultivation mechanism and use talent mechanism, establish economic belt test area dispensing system, solve the problem of unbalanced distribution of high-tech talents, promote more enterprises to develop high-tech products, reduce production cost, improve competitiveness, so that the whole area of sustained growth enterprise economic benefits.

5.4.4 Open-door to the Outside World

(1) Strengthening import and export trade

Hunan province is located in central China, linking the east with the west, linking the Beijing-Guangzhou high-speed railway with the node cities of the silk road, connecting the shanghai-Kunming high-speed railway with asean, with direct access to the eastern coastal ports, and also having convenient access to the pearl river delta and the Beibu gulf. Since a number of special customs surveillance zones have been approved. As cities along the "One Belt And One Road", they should regularly carry out activities related to foreign trade, attract domestic and foreign investment and strengthen cooperation and exchanges, so as to promote import and export trade and regional economic growth.

(2) Igorously develop the tourism industry

West Hunan district of Hunan province relatively weak economic foundation, urban development, but in fact have many national famous tourist resort, tourism as a breakthrough for the development of the regional economic development, local government should attach importance to the development of tourism industry, increasing investment in tourism industry, establish and improve the local tourism protection mechanism, increase the residents' jobs, development of an intelligent tourism products, to attract more tourists at home and abroad, to create awareness of the city, improve the competitiveness of the city. While promoting the development of the tourism industry, it has also promoted the development of other industries, and realized the rapid entry of the regional economy into a new stage, making significant contributions to improving the income of the employed and the quality of people's living standards.

VI References

[1] Hunan statistical yearbook 2013
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[2] Hunan statistical yearbook 2014
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[7]珠江_西江经济带城市经济活力评价研究_何汝群
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VII Appendix

Appendix a
```
format long g
clear;
clc;
alpha=0.3;
 beta=0.85;
gamma=0.18;
fc=40;
k=3;
X=load('elements.txt');
for ii = 5
    data = X(1:6,ii);
    %data = sort(data);
    S=reshape(data,[6,1]);
    plot(S,'r');
    n=length(S);
    a(1)=sum(S(1:k))/k;
    b(1)=(sum(S(k+1:2*k))-sum(S(1:k)))/k^2;
    s=S-a(1);
```

```
    y=a(1)+b(1)+s(1);

    f=zeros(144,1);
    for i=1:n+fc
        if i==length(S)
            S(i+1)=a(end)+b(end)+s(end-k+1);
        end
        a(i+1)=alpha*(S(i)-s(i))+(1-alpha)*(a(i)+b(i));
        b(i+1)=beta*(a(i+1)-a(i))+(1-beta)*b(i);
        s(i+1)=gamma*(S(i)-a(i)-b(i))+(1-gamma)*s(i);
        y(i+1)=a(i+1)+b(i+1)+s(i+1);
    end
    a = 0;
    b = 0;
    s = 0;
    hold on
    y = roundn(y,0);
    %y(7:9)'
    ansa(1:24, ii) = y(7: 30);
    plot(y,'b');
end
```