Team Number :	90108

Problem Chosen :	B

2019APMCM summary sheet

Urban economic vitality refers to the development ability and potential of a city's economic development. This paper based on factor analysis model and linear regression model makes a quantitative analysis of regional economic vitality and future development strategies.

For question 1, take Beijing for example, Identify 13 factors that affect economic vitality .They are per capita GDP ,per capita disposable income of residents ,growth rate of per capita disposable income， fiscal income per capita ,growth rate of fiscal revenue ,number of companies and so on. Obtain the structure model diagram. Based on the grey model of Beijing population short-term forecast and an improved grey prediction model based on BP neural network was constructed to predict the population of Beijing in the long term (2030).
The linear regression equation of population and Beijing GDP is y =27.749χ-36518.247.
The linear regression equation of enterprise income and Beijing GDP is y =5.013χ+906.962.
Population growth and corporate profits have a significant positive correlation with GDP, and play an important role in promoting regional economic vitality. Implement talent introduction policy to stimulate economic vitality

For question 2, also take Beijing for example, Beijing government implemented structural transformation from industrial economy to service economy in 2002. Using Beijing's GDP, the tertiary industry's total output value, the tertiary industry's contribution to GDP growth, and the tertiary industry's employment population as reference indicators, linearly fit the data before and after the transformation, and compare the values before and after transformation. The tertiary industry developed rapidly within a few years after the implementation of the policy in 2002. The proportion of the tertiary industry has stabilized since 2010.

For question 3, quantitative analysis of economic vitality through factor analysis.
Establish specific economic vitality evaluation indicators. Get three main factors, they are urban revenue, urban economic growth, city size. Evaluation index equation is as follows:

$$Score = (\frac{48.367}{75.564} \times FAC1 + \frac{15.818}{75.564} \times FAC2 + \frac{11.379}{75.564} \times FAC3) \times 100$$

Cluster analysis based on evaluation results. These 19 important cities in China can be divided into the following four categories by cluster analysis.

For question 4, analyze the main problems of the current Beijing economy by the model from question1 and question3, giving advice in four fields, they are high-tech development, Employment, education, preferential taxation.

Keywords: Evaluation Index System; Log-linear Regression; Factor analysis; Coefficient of Variation;

Contents

1.Introduction……1
2.Analysis……1
3.Question1……1
3.1 Analysis of factor that affect Urban Economic Vitality
3.2 Establish the appropriate relationship model
3.3 Impact of population changes and corporate vitality on economic vitality
3.3.1 Impact of population changes on economic vitality
3.3.2 Analysis of population growth factors based on grey relational analysis model
3.3.3 Impact of changes in corporate vitality on economic vitality
3.3.4 BP neural network model
3.3.5 Impact of Total Population and Corporate Profits on GDP
3.4 Research on plans to improve Beijing's economic vitality
4.Question2……15
4.1 Introduction
4.2 Analysis
4.2.1 Analysis of the change in the total output value of the tertiary industry
4.2.2 Analysis of the proportion of the tertiary industry
4.2.3 Analysis of the employment in tertiary industry
4.2.4 Economic contribution of the tertiary industry
4.3 Conclusion
5.Question3: Establish a mathematical model of regional economic vitality……20
5.1 data acquisition
5.2 Data standardization
5.3 Calculate the correlation coefficient of each indicator
5.4 Calculate the eigenvalue and the contribution rate of each main factor
5.5 Calculating Factor Load
5.6 Principal Factor Naming
5.7 Calculating the score of urban economic vitality
5.8 Conclusion
6.Question4……24
6.1 Analysis of economic status in Beijing
6.2 Development Proposals
6.2.1 High-tech development issues
6.2.2 Advice on Employment
6.2.3 Advice on Education
6.2.4 Advice on Policy tax
6.3 Summary
Reference……27

1 Introduction

"City’s Vitality" refers to the level of support of a city, region, or country for vital functions, ecological environment, and economic society. The entire vitality system is constituted by economic activity, social vitality, environmental vitality, and cultural vitality. The manifestation of urban economic vitality is determined by The ability of urban economic development in particular, but it is also largely affected by social, environmental and cultural vitality, which are closely related.

2.Analysis

The urban economic vitality refers to the capacity and potential of urban economic development. Chinese cities are in a period of rapid growth, and the economic vitality is mainly reflected in their ability to grow economically, to introduce capital and to attract high-quality labor.

3.Question1

3.1 Analysis of Urban Economic Vitality

3.1.1 GDP and its growth

GDP is the basis of the vitality of a city's economy. The economy of scale formed by the total economic volume leads to the accumulation of production and economic factors, thereby improving the output efficiency of the city. This paper uses GDP and its growth rate to measure the size of the city and its development trend.

3.1.2 Residents' income

Residents' income reflects the quantity and quality of labor force in the region to a certain extent, and the sustained and stable growth of labor force is an important driving force for urban economic vitality, while the influx of external urban population is an important part of the growth of urban labor force. The region with higher income levels have strong attractiveness to the labor force. At the same time, many studies have shown that a large number of labor transfers will further strengthen the city's further demand for labor, thereby promoting more labor to flow into the region.

3.1.3 Finance and Social Security

Government efficiency mainly depends on the degree of city government's intervention in the market, the policies adopted, the degree of openness of government affairs, the degree of public participation, and the efficiency of government’s work. The important indicators are financial and social security.

3.1.4 Foreign trade and foreign investment

Foreign trade and foreign investment are important indicators to measure the degree of openness of a city. Capital is one of the main factors for the sustained growth of the city's economy, and advanced technology is an important source of urban economic growth. It is the fastest way for Chinese cities to combine capital and technology by attracting a large number of foreign investment and developing foreign trade.

3.1.5 Technical level and education

On the one hand, technological progress has provided technical support for the development of the urban economy, on the other hand, it has also formed a huge attraction for high-quality production factors outside the city, thereby further promoting the development of the urban economy. Technical progress mainly includes: new products, new Proliferation of

processes and new technologies. Governments in developed countries often formulate a large number of policies to encourage technological progress, while providing various types of financial support for many basic and applied research in universities and research institutions. Empirical results indicate the development of university R & D centers significantly positive correlation with localized growth in many sectors.

3.1.6 Enterprises and their benefits

In modern cities, as one of the basic units of a city, an enterprise is not only an economic cell of urban vitality, but also the basis for expanding investment, expanding the scale of productivity development, and improving the level of productivity development. The quality of enterprises will directly determine the vitality of the city's economy.

3.1.7 Environment

The environment of a city includes not only its natural landscape, but also its social environment. With the advancement of technology, the location of many industrial enterprises has gradually got rid of the traditional resources, intermediate investment or market-oriented principles, beautiful landscape, culture Environmental factors such as a healthy and up-to-date atmosphere and conformity to the mainstream have become important factors that attract production factors and improve the quality of occupants to enhance the economic vitality of the city.

3.2 Establish the appropriate relationship model of influencing factors of economic vitality

3.2.1 Introduction of System Structure Model

The structural model is to describe the relationship between the factors of the system to represent a system model as a collection of entities. For example, if $S = \{S_1, S_2, \cdots, S_n\}$ represents a collection of entities, S_i represents elements in a collection of entities, $R = \{< x, y > |W(x, y)\}$ represents a set of relationship values between entities under a certain relationship (It can be represented by 0,1 whether there is a relationship W), then the element relationship R on the set S and the definition S represents the structural model under the system W, recored as { s, r). The structural model can be described by a directed connection graph or matrix. Next, we will establish the structural model of the regional economic vitality.

Among the numerous factors affecting regional economic vitality, the following 13 factors are considered:

Per capita GDP x_1 ,GDP per capita growth rate x_2 ,Per capita disposable income of residents x_3,Growth rate of per capita disposable income x_4,Fiscal income per capita of the year x_5,Growth rate of fiscal revenue x_6, Proportion of scientific research funds in GDP x_7, Number of companies x_8,,Total profits of large-scale enterprises x_9,Population growth rate x_{10}, Actual amount of foreign capital utilized in the year x_{11} ,,Education expenditure per capita x_{12},Per capita green space x_{13},.

3.2.2 adjacency matrix

Through empirical analysis and according to the relationship between regional economic vitality factors, we can obtain its adjacency matrix:

$$A=\begin{bmatrix}1&1&1&1&1&1&0&0&0&0&0&1&0\\1&1&1&1&1&1&0&0&0&0&0&1&0\\0&0&1&1&0&0&0&0&0&0&0&1&0\\0&0&1&1&0&0&0&0&0&0&0&1&0\\0&0&0&0&1&1&0&0&0&0&0&1&0\\0&0&0&0&1&1&0&0&0&0&0&1&0\\1&1&1&1&1&1&1&1&1&0&0&1&1\\1&1&1&1&1&1&0&1&1&1&0&0&0\\1&1&1&1&1&1&0&0&1&0&0&0&0\\0&0&0&0&0&0&0&0&0&1&0&0&1\\1&1&0&0&1&1&1&1&1&0&1&0&0\\0&0&0&0&0&0&0&0&0&0&0&1&0\\0&0&0&0&0&0&0&0&0&0&0&0&1\end{bmatrix}$$

Its i line from left to right shows the relationship between x_1x_2 ... ... with x_i, put 1 on the diagonal of the matrix x_i Affects other elements, 1 below the diagonal of the matrix indicates that other elements affectx_iTo find the structural model of regional economic vitality analysis.

3.2.3 Reachability Matrix

Finding the reachability matrix based on the adjacency matrix

$$M=(A+E)^4=(A+E)^2=\begin{bmatrix}1&1&1&1&1&1&0&0&0&0&0&1&0\\1&1&1&1&1&1&0&0&0&0&0&1&0\\0&0&1&1&0&0&0&0&0&0&0&1&0\\0&0&1&1&0&0&0&0&0&0&0&1&0\\0&0&0&0&1&1&0&0&0&0&0&1&0\\0&0&0&0&1&1&0&0&0&0&0&1&0\\1&1&1&1&1&1&1&1&1&1&0&1&1\\1&1&1&1&1&1&0&1&1&1&0&1&1\\1&1&1&1&1&1&0&0&1&0&0&1&0\\0&0&0&0&0&0&0&0&0&1&0&0&1\\1&1&1&1&1&1&1&1&1&1&1&1&1\\0&0&0&0&0&0&0&0&0&0&0&1&0\\0&0&0&0&0&0&0&0&0&0&0&0&1\end{bmatrix}$$

1 in the reachability matrix means that x_i can affect x_j no matter in direct ways or indirect ways. In the reachability matrix, x_2, x_4 and x_6 all correspond the same line and the same column, which can forming a loop. A new reachability matrix can form by removing x_2, x_4 and x_6.

3.2.4 Hierarchical division.

x_i	$R(x_i)$	$A(x_i)$	$R(x_i)\cap A(x_i)$
x_1	1,3,5,12	1,7,8,9,11	1
x_3	3,12	1,3,7,8,9,11	3
x_5	5,12	1,5,7,8,9,11	5
x_7	1,3,5,7,8,910,12,13	7,11	7
x_8	1,3,5,8,9,10,12,13	7,8,11	8
x_9	1,3,5,9,12	7,8,9,11	9
x_{10}	10,13	7,8,10,11	10
x_{11}	1,3,5,7,8,9,10,11,12,13	11	11
$\#x_{12}$	12	1,3,5,,7,8,9,11,12	12
$\#x_{13}$	13	7,8,10,11,13	13

x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
x_1	1,3,5	1,7,8,9,11	1
$\#x_3$	3	1,3,7,8,9,11	3
$\#x_5$	5	1,5,7,8,9,11	5
x_7	1,3,5,7,8,910	7,11	7
x_8	1,3,5,8,9,10	7,8,11	8
x_9	1,3,5,9	7,8,9,11	9
$\#x_{10}$	10	7,8,10,11	10
x_{11}	1,3,5,7,8,9,10,11	11	11

x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
$\#x_1$	1	1,7,8,9,11	1
x_7	1,7,8,9	7,11	7
x_8	1,8,9	7,8,11	8
x_9	1,9	7,8,9,11	9
x_{11}	1,7,8,9,11	11	11

x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
x_7	7,8,9	7,11	7
x_8	8,9	7,8,11	8
$\#x_9$	9	7,8,9,11	9
x_{11}	7,8,9,11	11	11

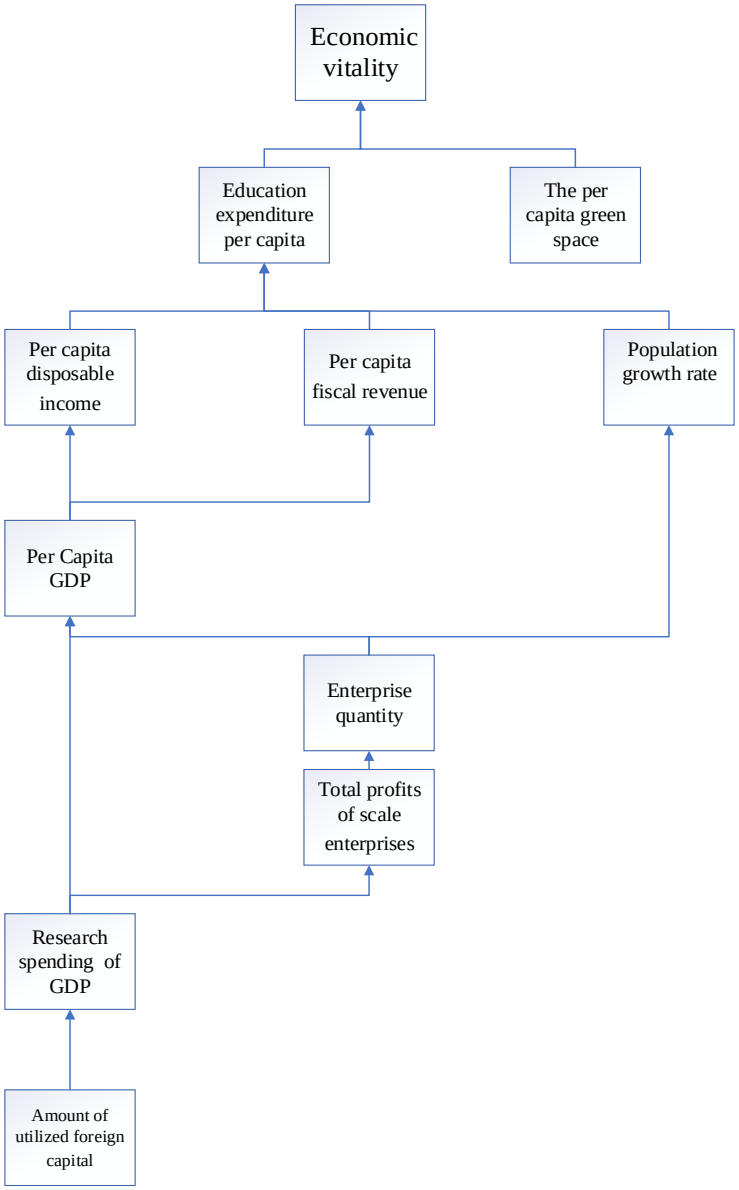
x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
x_7	7,8	7,11	7
$\#x_8$	8	7,8,11	8
x_{11}	7,8,11	11	11

x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
$\#x_7$	7	7,11	7
x_{11}	7,11	11	11

x_i	$R(x_i)$	$A(x_i)$	$R(x_i) \cap A(x_i)$
x_{11}	11	11	11

3.2.5 Relational Structure Model

According to the ordered reachability matrix, the lower-level factors can affect the upper-level factors, and the structural model is established as shown in the figure.



3.3 Impact of demographic changes and corporate vitality on economic vitality

3.3.1 Impact of population changes on economic vitality

It can be seen from the relevant literature that the determinants of population growth are birth rate, mortality, and population base, so the total population of a city at a time = population base + net population increase. But at the same time, population distribution, population quality, government macro policies and Many factors such as population structure (such as age structure, gender ratio, and urban-rural differences) can affect the fluctuation of birth rate and mortality rate, thereby fundamentally affecting the growth of urban population.

Taking into account the above factors, the three indicators of urban and rural population ratio, aging rate and gender ratio of men and women are finally selected. Based on the relevant literature reviewed, the three factors of urban and rural population ratio, aging rate and gender ratio of men and women are finally selected and based on 2010-2016 The grey vector analysis of statistical yearbook data was used to find the correlation vector. Then, this paper can establish

the differential equations between the total net population increase and the urban-rural population ratio, the aging rate, and the influencing factors of male and female sex ratios, which can quantitatively analyze the various factors in Beijing. The relationship between these influencing factors and the total population.

1.Model assumptions

(1) The population data are all resident population data.

(2) Do not consider the impact of local policies in other regions on the population of Beijing.

(3) Beijing's evacuation policy for non-capital functions is only for general industries and does not affect the population.

3.2.2.Analysis of population growth factors based on grey relational analysis model

2.1 Source and processing of data

Beijing was selected as the research object. Firstly, this paper analyzes the factors that affect the total net increase of the population. By consulting the literature [1], we select three factors: population aging rate, gender imbalance rate, and urban congestion coefficient and population growth rate to establish a differential equation to predict the population. Through relevant statistical yearbooks and data from the Beijing Municipal Bureau of Statistics, we get the following table:

table 1 Statistical Table of Influencing Factors

Year	Urban Population	Rural Population	Urban and Rural Population Ratio	Sex Ratio	The Rate of Population Aging
2007	1379.9	253.10	5.45	1.03	13.70
2008	1439.1	255.90	5.62	1.03	14.10
2009	1491.8	263.20	5.67	1.04	14.00
2010	1686.4	275.50	6.12	1.07	12.60
2011	1740.7	277.90	6.26	1.06	13.30
2012	1783.7	285.60	6.25	1.07	13.80
2013	1825.1	289.70	6.30	1.07	14.00
2014	1859.0	292.60	6.35	1.06	15.00
2015	1877.7	292.80	6.41	1.06	15.60
2016	1879.6	293.30	6.41	1.05	16.00
2017	1877.2	293.40	6.40	1.05	16.10
2108	1862.6	291.40	6.39	1.04	16.20

2.2 Short-term forecast of indicator values based on gray model

When the data is too small, the gray prediction model has high accuracy for short-term predictions. For the previous indicator data, this paper uses the gray model to perform short-term prediction analysis on the data. Due to too much data, this article uses the town as an example to explore the detailed process. Use gray predictions to predict urban and rural population ratios, aging rates, and gender ratios.

Through calculation and statistical analysis, this paper obtains the statistical results shown in the table:

item		Relative residual error	Grade ratio deviation	Variance ratio	Small error probability	Error accuracy class
Urban	Population	<0.1	<0.1	0.036	1	Good

In the same way, the predicted values of other items can be obtained by using gray prediction. The final results are shown in the following table:

Grey prediction of population indexes in Beijing

Year	Urban and Rural Population Ratio	Sex Ratio	The Rate of Population Aging
2017	6.42	1.05	17.21
2018	6.45	1.04	17.53
2019	6.47	1.05	17.64
2020	6.49	1.06	17.71

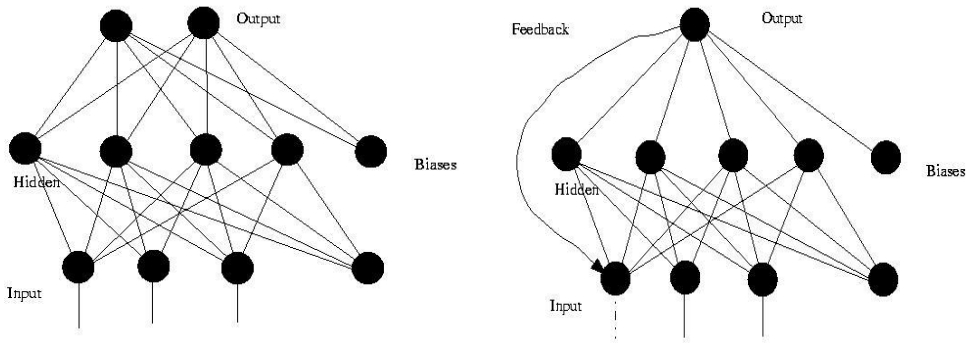
According to the logistic model, the predicted urban-rural population ratio, gender ratio and aging rate are substituted into equation (22), and the total population of Beijing in 2020 is 22.9873 million.

3.2.3 Prediction of improved grey prediction model based on BP neural network

According to the above grey prediction model, the total population of Beijing is predicted in the medium and short term (2020). Considering that in the prediction system, neural network has the advantages of parallel computing, strong fault tolerance, strong adaptive ability, etc., and grey system theory has the advantages of less sample data, simple principle, convenient operation, high short-term prediction accuracy, testability, etc. But grey prediction is not suitable for long-term prediction, so according to the grey model prediction results obtained previously, this paper adds neural network. Based on the modified analysis of the network model, an improved grey prediction model based on BP neural network is constructed to predict the population of Beijing in the long term (2030).

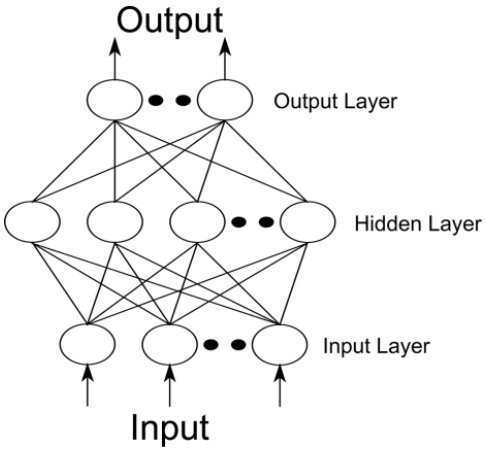
3.2.4 BP neural network model

In the neural network model, neural networks can be divided into feedforward neural networks, feedback neural networks, and self-organizing neural networks according to the distinction of the neural network interconnection methods. The schematic diagram of the structure is shown in the following figure.



Feedforward neural network and feedback neural network

As a neural network model, the BP neural network is widely used because of its powerful functions. The BP neural network is a feedforward neural network using the BP learning algorithm. The schematic diagram of its structure is shown below.



BP neural network structure

After passing the judgment, the results of the impact factors such as the urban population are calculated. The data values from 2007 to 2011 are used as input values, and the data values from 2011 to 2015 are used as expected outputs. A BP neural network training model is established, and the output threshold and Weights are calculated, see the table below.

Output threshold and weight

Input Layer to Hidden Layer Weight	Thresholds of neurons in the middle layer	Middle layer to output layer weight	Thresholds of neurons in the output layer
5.987858941	-8.107568062	0.272435093	
-7.006988286	4.886001342	0.526334702	
-4.495889666	1.456603444	-0.639048936	1.155094239
-6.056387491	-1.878218139	0.780360473	
-4.085083234	-3.717745936	-1.745117574	

The prediction results of the gray model are input into the neural network training model, and new prediction results are obtained through training. The statistical analysis of the results is shown in the following table:

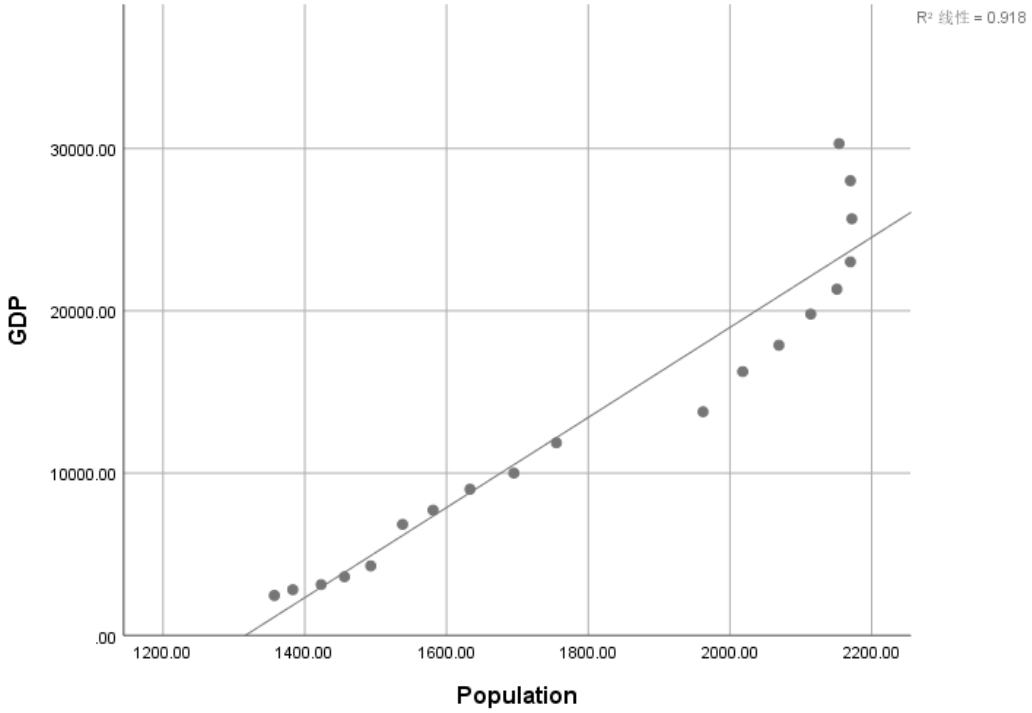
Forecast results of Beijing's population indicators from 2017 to 2030

Year	Urban and Rural Population Ratio	Sex Rate	The Rate of Population Aging
2017	6.42	1.06	17.23
2018	6.45	1.04	17.52
2019	6.46	1.05	17.62
2020	6.48	1.07	17.68
2021	6.49	1.07	17.69
2022	6.49	1.06	17.71
2023	6.51	1.08	17.72
2024	6.52	1.07	17.73
2025	6.53	1.06	17.79
2026	6.54	1.09	17.92
2027	6.56	1.08	18.02
2028	6.57	1.11	18.43
2029	6.59	1.11	18.64
2030	6.62	1.09	18.95

From the predicted value of the population index, it is substituted into formula (22), and the long-term forecast of the total population of Beijing in 2030 is 35.416 million.

Beijing's population will increase by more than 13 million people. This is a huge value and will inject strong vitality into Beijing's economy. As the city expands in size, Beijing will add more enterprises, increase the city's GDP, and increase the Beijing's urban economic vitality index. But the predicted aging rate in Beijing is 18.95%, which is already very high, which will be a burden on economic vitality.

Next, study the relationship between population and GDP.The following figure is a scatter plot of population and GDP.It can be seen from the figure that there is a clear positive correlation between these two factors.



Let's build a linear regression model by using spss19.0:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.958[a]	.918	.914	2681.11277	.336

a. Predictors: (Constant), Population

b. Dependent Variable: GDP

It can be known that the absolute value of the correlation coefficient is 0.958 and the determination coefficient is 0.918. The effect of the model close to 1 is very good.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1376258547	1	1376258547	191.456	.000[b]
	Residual	122202216.9	17	7188365.699		
	Total	1498460764	18			

a. Dependent Variable: GDP

b. Predictors: (Constant), Population

The test of the regression coefficient is F= 191.456, and P<0.05.The model is statistically significant.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-36518.247	3671.600		-9.946	.000	-44264.647	-28771.848
	Population	27.749	2.005	.958	13.837	.000	23.518	31.980

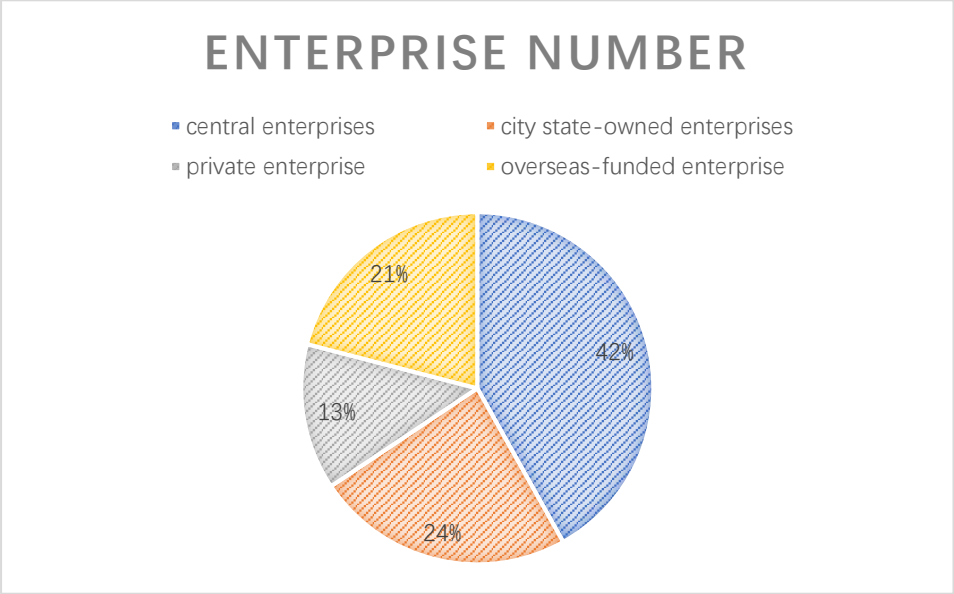
a. Dependent Variable: GDP

The coefficient table gives the constants in the regression equation, the estimated values and test results of the regression coefficients, and the regression equation between the population and GDP:$\bar{y} = 27.749\chi - 36518.247$

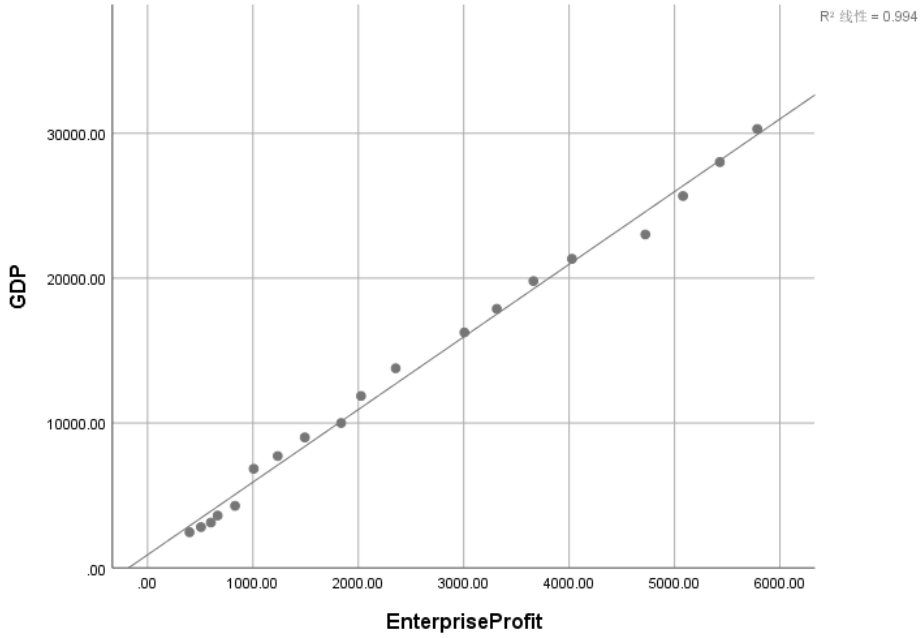
3.3 Impact of changes in corporate vitality on economic vitality

From 2009 to 2018, there were 40,176,400 registered enterprises (excluding individual industrial and commercial households, the same below) in 31 provinces (municipalities, autonomous regions, and autonomous regions) (excluding Hong Kong, Macao, and Taiwan regions). As of September 2019, there were 9,735,300 companies. Enterprises were cancelled (cancellation rate: 24.28%), and 30,422,600 surviving companies were survived. A total of 1.521 million Beijing cities were registered and 338,000 were cancelled, with a cancellation rate of 22.2% lower than the national average.

Recently, Fortune Magazine issued a new World Top 500 list. This year, the number of Chinese companies on the list reached 120. Among the companies on the list in China, the number of companies based in Beijing reached 53, accounting for 500 of the world. 10.6% of the strong total, accounting for 44.2% of the number of Chinese companies shortlisted, and Beijing has ranked first in the world's cities for 6 consecutive years. Beijing has a total of 4,007 headquarters companies, accounting for less than 1% of the total number of Beijing enterprises, but the proportion of assets 86.9%, operating income accounted for 67.8%, realized profits accounted for 88.7%. These large enterprises have injected a strong impetus into Beijing's economic development. Beijing has a total of 4,007 headquarters companies, a year-on-year increase of 17.1%; from the perspective of the nature of the company, 4007 Among the headquarters enterprises, there are 1,123 central enterprise headquarters, 636 municipal state-owned enterprise headquarters, 360 private enterprise headquarters, and 562 foreign-owned headquarters. There are 1,220 state-owned high-tech enterprises. The "Beijing National Science and Technology Innovation Center Index 2019" released on the parallel forum of Zhongguancun Forum "Building a Global Innovation Network and Building a World-Class Science City" shows that in 2018, Beijing Science and Technology innovation. The center index score reached 322.9, which is nearly double the 2014 index score. From 2014 to 2018, the annual growth rate of Beijing's venture capital investment and the number of unicorn companies has exceeded 40%. On the whole, Beijing's National Science and Technology Innovation Center The index score showed a rapid growth trend. In 2018, the Beijing Science and Technology Innovation Center index score reached 322.9, which is nearly double the 2014 index score, with an average annual growth rate of more than 18%, which is significantly higher than the average annual growth rate of 11.8% from 2010 to 2013. The calculation results show that in the past five years, the construction of Beijing's science and technology innovation center with global influence has achieved remarkable results.



The following figure is a scatter plot of corporate profits and GDP.It can be seen from the figure that there is a clear positive correlation between these two factors.



Let's build a linear regression model by using spss19.0:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.997[a]	.994	.993	738.37673	1.057

a. Predictors: (Constant), EnterpriseProfit

b. Dependent Variable: GDP

It can be known that the absolute value of the correlation coefficient is 0.997 and the determination coefficient is 0.994, which is very close to 1.The effect of the model is very good.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1489192360	1	1489192360	2731.460	.000[b]
	Residual	9268403.415	17	545200.201		
	Total	1498460764	18			

a. Dependent Variable: GDP

b. Predictors: (Constant), EnterpriseProfit

The test of regression coefficient f = 2731.460. P value <0.05, the model is statistically significant.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	906.962	295.587		3.068	.007	283.328	1530.597
	EnterpriseProfit	5.013	.096	.997	52.263	.000	4.811	5.216

a. Dependent Variable: GDP

The coefficient table gives the constants in the regression equation, the estimated values and test results of the regression coefficients, and the regression equation between the population and GDP:$\bar{y} = 5.013\chi + 906.962$

3.3.5 Impact of Total Population and Corporate Profits on GDP

Next, the impact of the combined population and corporate profit on GDP is discussed. The following uses the spss19.0 to establish a multiple linear regression model to study the relationship between these three factors:

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Population, EnterprisePro fit[b]	.	Enter

a. Dependent Variable: GDP

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.997[a]	.995	.994	684.90460	1.219

a. Predictors: (Constant), Population, EnterpriseProfit

b. Dependent Variable: GDP

It can be known that the absolute value of the correlation coefficient is 0.997 and the determination coefficient is 0.995, which is very close to 1.The effect of the model is very good.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1490955255	2	745477627.4	1589.185	.000[b]
	Residual	7505509.011	16	469094.313		
	Total	1498460764	18			

a. Dependent Variable: GDP

b. Predictors: (Constant), Population, EnterpriseProfit

The test of regression coefficient F=1589.185.P<0.05, the model is statistically significant.

Coefficients[a]

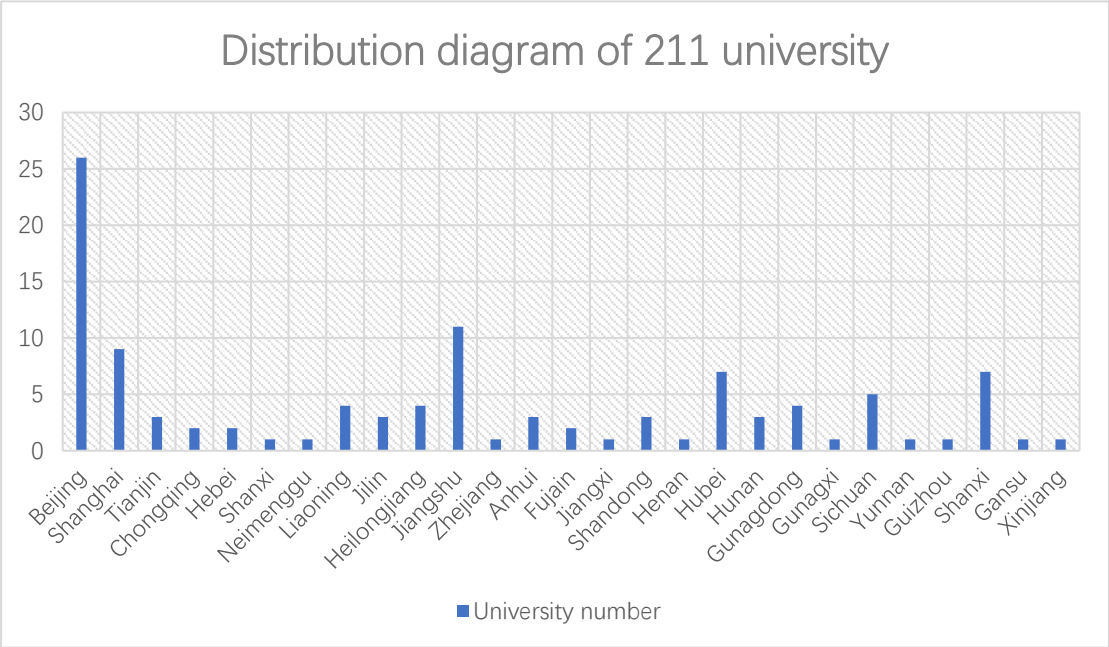
Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-3536.362	2308.395		-1.532	.145
	EnterpriseProfit	4.485	.287	.892	15.637	.000
	Population	3.201	1.651	.111	1.939	.070

a. Dependent Variable: GDP

The coefficient table gives the estimated values and test results of the constant terms and regression coefficients in the regression equation, the number of population χ_1 ,Corporate profitsx_2With GDP yThe regression equation between:$y = 3.201\chi_1 + 4.485x_2 - 3536.362$ It can be seen that population growth and corporate profits have a significant positive correlation with GDP, and have a huge role in promoting regional economic vitality.

3.4 Research on plans to improve Beijing's economic vitality

There are 26 211 colleges and universities in Beijing, and the number of graduates from these colleges is as high as 100,000 each year. This is a huge talent pool, and the full use of talent resources will bring strong economic vitality to Beijing. The following picture shows the provinces and cities of the country 211 college distribution map.



Implement a talent introduction strategy, increase investment in talents, greatly discount college students in terms of purchase, housing, internships, entrepreneurship funds, etc., extend the period for college students to choose their own careers, and further liberalize the residence conditions for college students to settle in Wuhan. Traineeships and innovation and entrepreneurship are the core of policy preferences, providing entrepreneurial services for college students and other groups, and accounting for the number of successful entrepreneurial entities and driving employment, and giving certain rewards, especially in IT, Internet +, new energy, and electronic information. Financial industry, etc.,

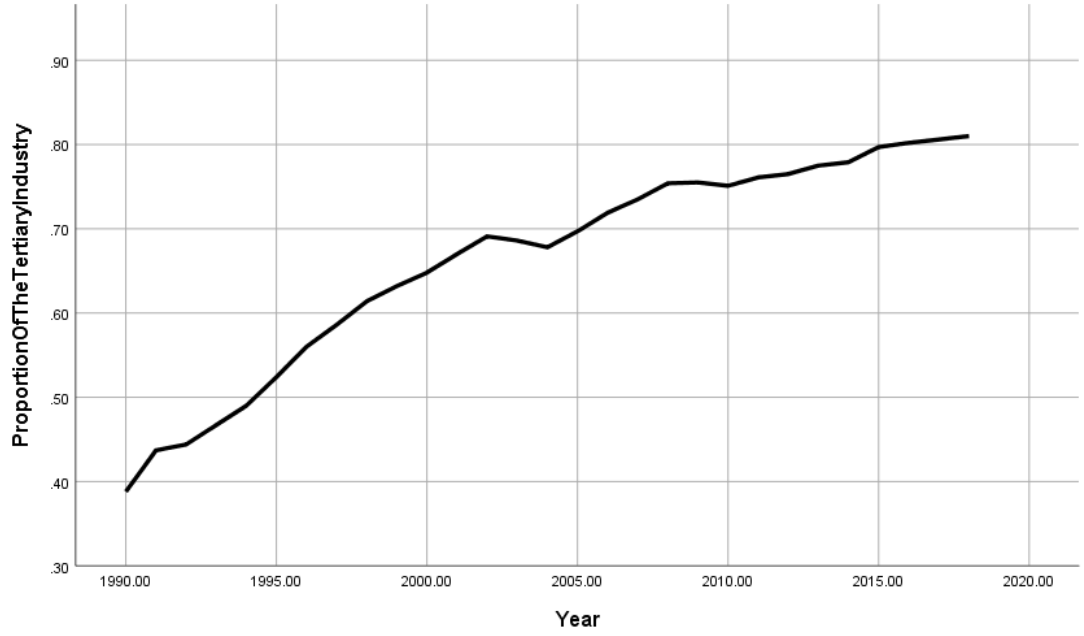
The policy intensity of developed areas such as Beijing is not higher than that of other first-tier cities, but because of its better legal environment, sound infrastructure and perfect industrial chain structure, many universities and colleges continue to export high-level talents. The gathering of numerous enterprises and institutions has created a large number of employment opportunities. If the talent introduction policy can be implemented, it can make up for the deficiencies between it and other cities and retain more talents, especially research institutes and various institutions. Universities and universities will increase their efforts to introduce talents, which can also promote technological progress and stimulate economic vitality.

Question 2

4.1 Introduction

Relevant data show that in the 70 years since the founding of New China, Beijing has undergone a structural transformation from a service-oriented experience to an industrial economy and then to a service-oriented economy. This must correspond to the transformation of specific economic policies. The "three two one" economic layout was formed, and the tertiary industry

accounted for the largest proportion, followed by the secondary industry, and finally the primary industry. Since the reform and opening up, Beijing has actively adjusted and optimized the layout of the industrial structure. According to statistical data, 1994 Beijing's tertiary industry added value accounted for 49.1%, surpassing the secondary industry for the first time, and continued to rise in the following time. By 2018, Beijing's tertiary industry accounted for more than 80% .The figure below shows Beijing Proportion of the tertiary industry's value added from 1989 to 2018:



According to the Guiding Opinions of the General Office of the People's Government of Beijing Municipality on Further Accelerating the Development of the Tertiary Industry issued by Beijing in 2002, the group members have economic policies on adjusting the layout of the tertiary industry. , The contribution rate of tertiary industry to GDP growth, the contribution rate of tertiary industry to increase employment, etc. as reference indicators, linearly fit the data before and after the transformation, and objectively characterize economic policies by comparing the numerical differences before and after the transformation. Short- and long-term effects of transition on economic vitality.

4.2 Analysis

4.2.1Analysis of the change in the total output value of the tertiary industry

Solve the total output value of the tertiary industry before the transformation and the linear regression equation after the transformation:

Before the transition:

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Case Sequence	203.978	15.012	.974	13.587	.000
(Constant)	-289.177	110.488		-2.617	.026

The linear regression equation is$y = 203.978x - 289.177$
After the transition:
The linear regression equation is$y = 1358.24x - 421.132$

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Case Sequence	1358.240	53.326	.989	25.470	.000
(Constant)	-421.132	546.434		-.771	.453

The slope has risen from 203.978 to 1358.24, which shows that the policy transition has greatly promoted the development of the tertiary industry.

4.2.2Analysis of the proportion of the tertiary industry:

The ratio does not meet the requirements of linear regression. You can use the logistic regression equation to analyze. First, use the SPSS to perform log-time regression prediction on the proportion of the tertiary industry before the transformation to obtain the 2003-2018 forecast data. The actual data of 2018 were adjusted for the standardization of the index prediction, and the resulting data is collated as shown below:

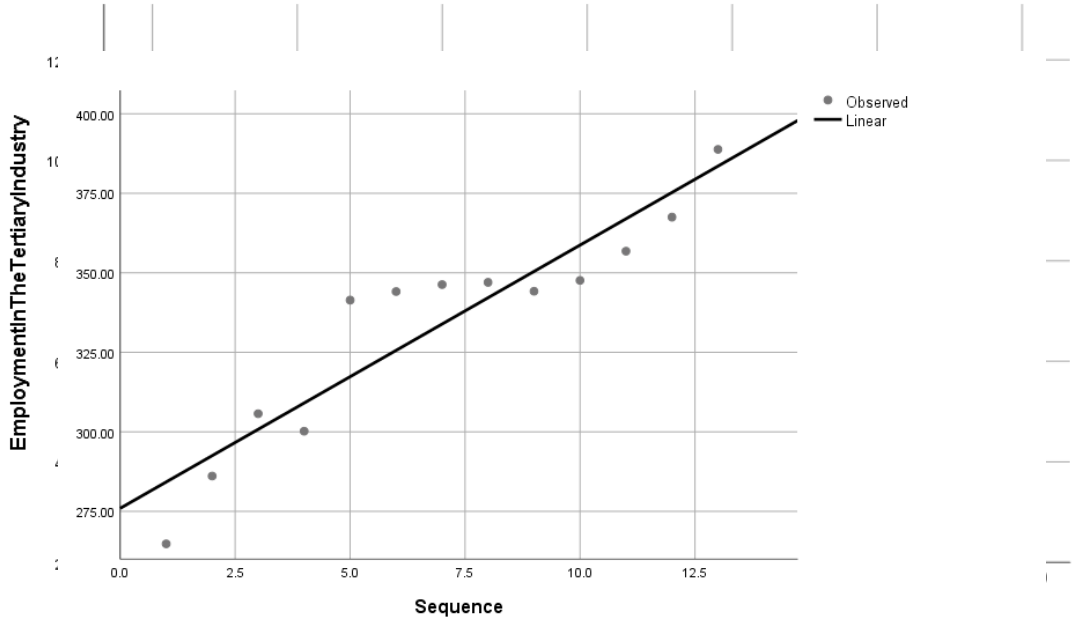
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Before the transformation	0.661	0.670	0.678	0.685	0.692	0.698	0.705	0.711
After the transformation	0.656	0.692	0.712	0.727	0.738	0.748	0.756	0.763
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Before the transformation	0.716	0.722	0.727	0.732	0.737	0.742	0.746	0.751
After the transformation	0.769	0.774	0.778	0.783	0.787	0.791	0.794	0.797

It can be seen that the share of the tertiary industry increased rapidly in the short years after the implementation of the policy in 2002, which played a huge role in the development of the tertiary industry in the short term but gradually stabilized after 2010. This shows that the development of the tertiary industry has become increasingly mature.

4.2.3Tertiary employment

It is ranked by collecting the number of employees in the tertiary industry from 1990 to 2018, as shown in the figure:

It can be seen from the figure that there was an obvious inflection point in 2002, and the number of employees rose rapidly.

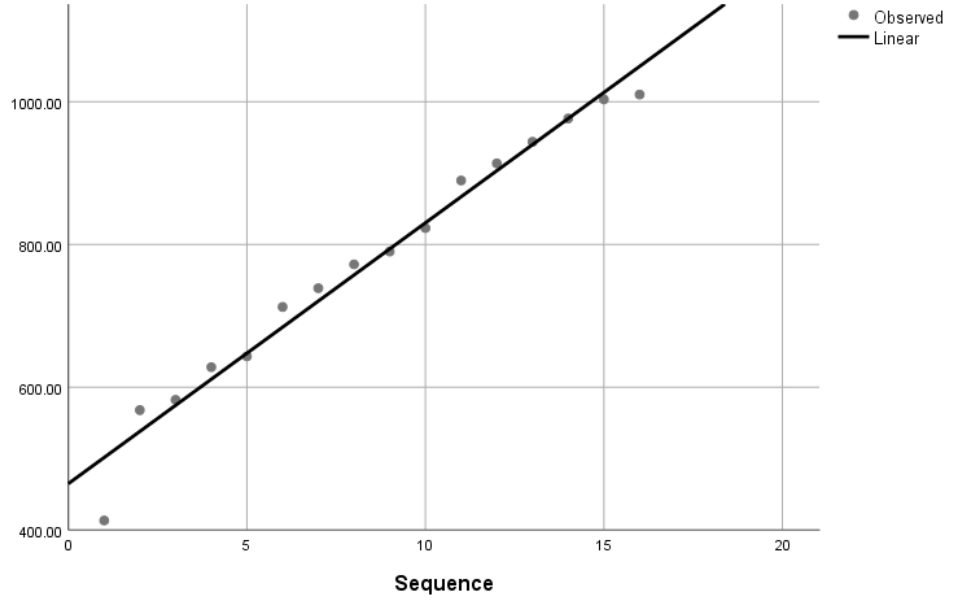


Before the transition:

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Case Sequence	8.275	.993	.929	8.334	.000
(Constant)	275.958	7.882		35.013	.000

Linear regression equation:$y = 8.275x + 275.958$



Coefficients

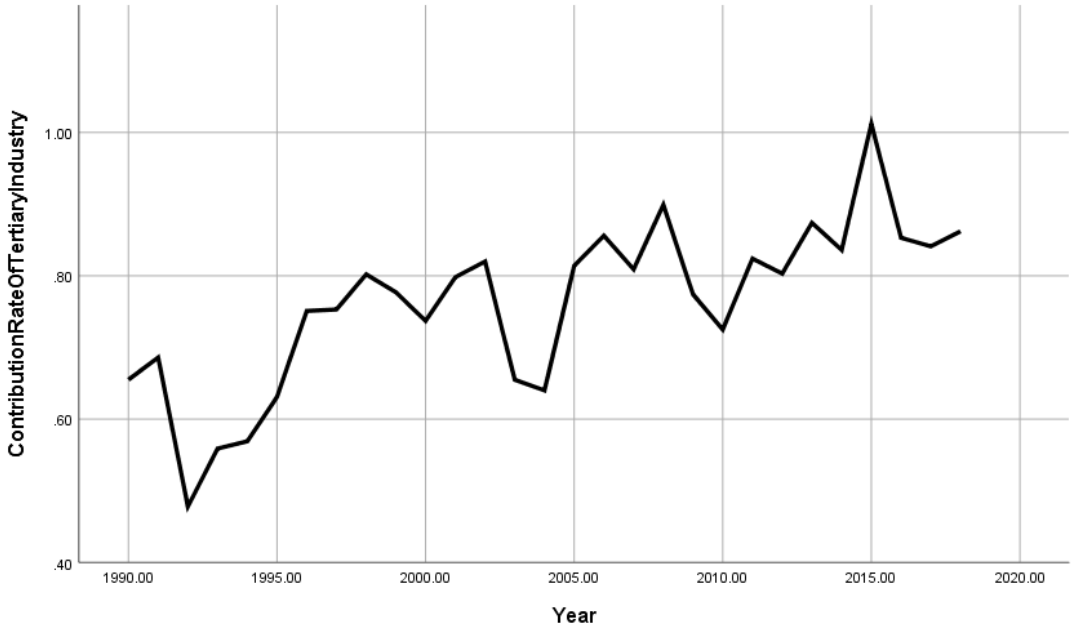
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Case Sequence	36.537	1.637	.986	22.321	.000
(Constant)	464.975	15.828		29.376	.000

Linear regression equation:$y = 36.537x + 464.975$

Compared with the pre-transition, the linear regression equation has obvious differences, indicating that the economic transformation has a great effect on the number of employment in the tertiary industry.

4.2.4 Economic contribution rate of the tertiary industry

Evaluate the impact of the tertiary industry on the economic vitality of Beijing through the contribution of the tertiary industry to the economy of Beijing. The following figure shows the contribution rate of the tertiary industry (the annual added value of the tertiary industry is greater than the annual added value of GDP).



It can be seen from the figure that from 2002, the contribution rate of the tertiary industry always fluctuated below 80%, after the economic policy transition, it rose rapidly in the five years after 2002, and fluctuated above 80% in the next ten years. You can see after the economic transformation, the tertiary industry has a great effect on Beijing's economic vitality.

4.3 Conclusion:

The structural transformation of Beijing from an industrial economy to a service economy has been very successful. Through this economic transformation, Beijing's employment situation has been improved, which has laid a solid foundation for Beijing's future healthy development, and has greatly promoted Beijing's GDP's Growth, and economic vitality has been greatly improved.

5.**Question3:**Establish a mathematical model of regional economic vitality

Through the construction of the influence factor relationship model in the first question, the next step is to use factor analysis to perform quantitative analysis. The premise of using factor analysis is that the selected index data is suitable for factor analysis, and if it is not suitable, this method cannot be used. If the index data can be subjected to factor analysis, the extracted factors must have a clearer interpretation meaning, otherwise this method is not suitable for use. The indicators selected previously are used below to make use of the 2018 National Economic and Social Development Statistics Bulletin of each city. Relevant data is sorted, and the specific values of each indicator are calculated. Factor analysis is performed using spss19.0 software.

5.1 data acquisition

The data in this article comes from the 2018 China City Statistical Yearbook and online search. Some of the data are directly or indirectly calculated from the above data.

5.2 Data standardization

Statistics for each city, assuming its indicator set matrix isx_{ij} In order to eliminate the impact of the dimension on the evaluation, first of all, the original index set matrix is standardized, and

the standardization of the data is based on the range normalization.

5.3 Calculate the correlation coefficient of each indicator

Based on the above data standardization, the correlation coefficient matrix of each data is calculated.

5.4 Calculate the eigenvalue and the contribution rate of each main factor

Find the eigenvalues by performing the inner product of the correlation coefficient matrix (r) λ_i, Solve the inverse compact transformation to obtain the corresponding eigenvectorI_{ij}The jacobi method is used to obtain the iterative accuracy of the eigenvalues, and then the number of main factors is determined according to the cumulative percentage of the eigenvalues, and the contribution rate of each main factor is calculated. The calculation results are shown in Table 2.

Total Variance Explained

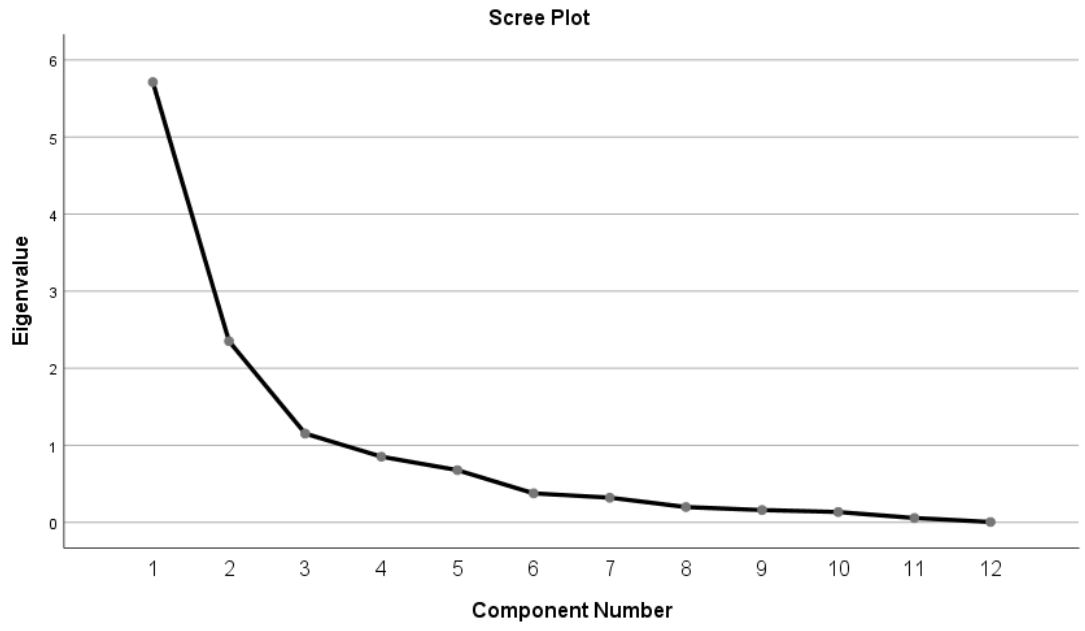
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.712	47.604	47.604	5.712	47.604	47.604	5.712	47.596	47.596
2	2.351	19.594	67.198	2.351	19.594	67.198	2.032	16.935	64.531
3	1.153	9.607	76.805	1.153	9.607	76.805	1.473	12.274	76.805
4	.853	7.107	83.912						
5	.678	5.646	89.559						
6	.377	3.141	92.700						
7	.320	2.670	95.369						
8	.199	1.657	97.026						
9	.160	1.335	98.361						
10	.135	1.121	99.482						
11	.057	.472	99.954						
12	.005	.046	100.000						

Extraction Method: Principal Component Analysis.

The gravel chart is used to show the importance of each factor. The horizontal axis is the factor number, and the vertical axis represents the size of the characteristic root.

The steeper the slope, the larger the corresponding characteristic value, the more obvious the effect. Generally, the root with a characteristic value greater than 1 is selected factor.

5.5 Calculating Factor Load



The calculation of each factor load is shown in Table 3.

Rotated Component Matrix[a]

	Component		
	1	2	3
PerCapitaGDP	.634	-.006	.646
GDPPerCapitaGrowthRate	-.171	.892	.201
PerCapitaDisposableIncome	.814	.029	.323
PerCapitaDisposableIncomeGrowthRate	.288	.795	-.184
PerCapitaRevenue	.866	.049	.270
RateOfRDToGDP	.914	.010	-.062
RevenueGrowthRate	-.033	.658	.275
EnterpriseQuantity	.840	.002	.093
TotalProfitsOfEnterprises	.932	-.055	-.182
PopulationGrowthRate	-.200	.372	.723
ForeignInvestment	.827	.096	-.242
PerCapitaExpenditureOnEducation	.807	-.130	-.319

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

a. Rotation converged in 7 iterations.

5. 6 Set Factor Naming

After the rotation, the obtained rotation component matrix,. It can be seen that the first common factor is per capita GDP, per capita disposable income, and per capita fiscal income.Proportion of research funding to GDPThe amount of foreign capital actually used by corporate profits, and per capita education expenditure can be named as urban revenue (that is, all revenues from government, residents, enterprises, etc.) in the city according to the main factors.

The second common factor: the three-year GDP growth rate, the per capita disposable income growth rate, and the fiscal revenue growth rate, which mainly reflect the growth of the urban economic aggregate, and can be named urban economic growth.

The third common factor is the population growth rate and the number of enterprises, which can be named the city size.

The three common factors reflect the overall level of the local economic vitality from different aspects. It is difficult to make a comprehensive evaluation using a certain factor alone. The factor considers the overall score based on the tolerance contribution ratio corresponding to each common factor as a weight.

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	6.313	48.565	48.565	6.313	48.565	48.565	6.288	48.367	48.367
2	2.357	18.131	66.696	2.357	18.131	66.696	2.056	15.818	64.185
3	1.153	8.869	75.564	1.153	8.869	75.564	1.479	11.379	75.564
4	.955	7.347	82.912						
5	.678	5.214	88.125						
6	.576	4.432	92.557						
7	.325	2.500	95.057						
8	.244	1.878	96.935						
9	.160	1.233	98.168						
10	.146	1.121	99.289						
11	.064	.491	99.780						
12	.024	.181	99.961						
13	.005	.039	100.000						

Extraction Method: Principal Component Analysis.

5.7 Calculating the score of urban economic vitality

According to the formula:

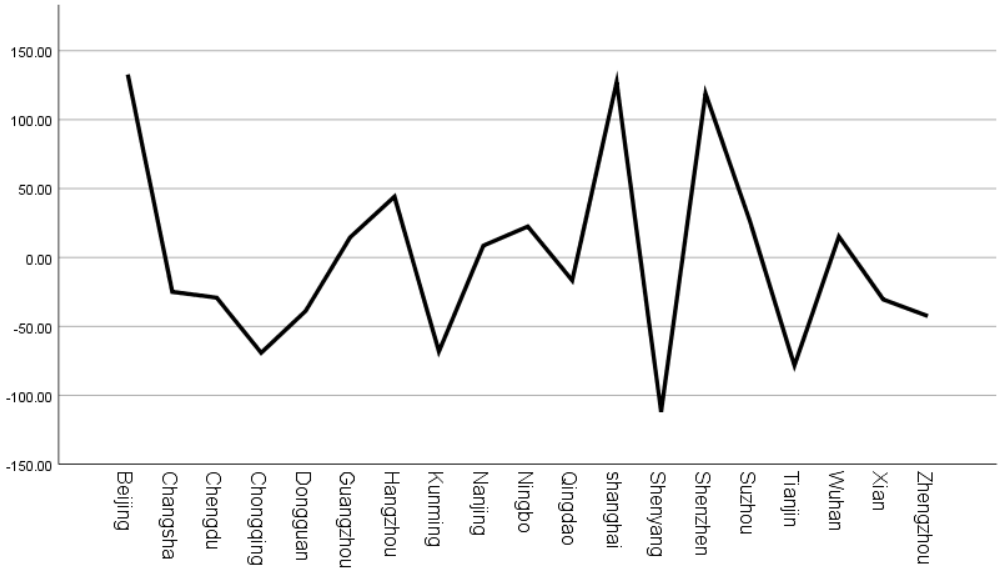
$$Score = (\frac{48.367}{75.564} \times FAC1 + \frac{15.818}{75.564} \times FAC2 + \frac{11.379}{75.564} \times FAC3) \times 100$$

In order to calculate the comprehensive score of each city.

NO	City	First factor	Second factor	Third factor	Gross score
1	Beijing	154.96	2.28	-24.46	132.78
2	shanghai	138.78	0.90	-12.53	127.15
3	Shenzhen	85.70	0.72	32.63	119.05
4	Hangzhou	17.80	12.00	14.36	44.16
5	Suzhou	18.69	-1.95	9.50	26.24
6	Ningbo	-8.86	21.84	9.53	22.51
7	Wuhan	6.46	7.27	1.45	15.17
8	Guangzhou	13.22	-14.45	15.75	14.53
9	Nanjing	-3.79	6.96	5.40	8.57
10	Qingdao	-15.71	0.83	-1.74	-16.62
11	Changsha	-40.26	2.58	12.75	-24.94
12	Chengdu	-36.53	16.57	-9.20	-29.16
13	Xian	-49.45	14.95	3.98	-30.52
14	Dongguan	-32.51	1.32	-7.68	-38.87
15	Zhengzhou	-58.06	12.79	2.80	-42.47
16	Kunming	-68.43	20.36	-20.08	-68.15
17	Chongqing	-39.23	-1.02	-28.90	-69.15
18	Tianjin	-6.49	-67.09	-4.80	-78.38
19	Shenyang	-76.26	-36.87	1.23	-111.90

The line of urban economic active index

Cluster analysis based on evaluation results



According to the above cluster analysis, the urban economic vitality indexes of 19 important cities in China can be divided into the following four categories.

The first category: Beijing, Shanghai, Shenzhen; the second category: Hangzhou, Suzhou, Ningbo, Wuhan, Guangzhou, Nanjing; the third category: Qingdao, Changsha, Chengdu, Xian, Dongguan:; the fourth category: Zhengzhou, Kunming, Chongqing, Tianjin, Shenyang.

The first and second cities are almost all located in the eastern region. It can be seen that the economic vitality of the eastern region is large, and the economic vitality of other regions is weak. It is necessary to carry out appropriate economic policy transformation to stimulate economic vitality.

5.8 Conclusion

Through the analysis, the positive effects of various indicators on the economic vitality of the city are well verified. Factor analysis is performed on the indicator system of urban economic vitality to eliminate the overlap of information caused by the correlation of various indicators. Fiscal revenue, annual per capita disposable income of residents, total profits of large-scale enterprises, the amount of foreign capital actually used in the year, and per capita education expenditures, which are also very important are the per capita GDP as a comprehensive indicator. Not as significant as the theory describes.

6.Question 4

6.1 Analysis of the status quo in Beijing:

In recent years, Beijing's economy has maintained a generally stable, stable and good development trend. From the perspective of the operation of the main areas, the production area has seen a good growth trend, the demand area has basically stabilized, the people's livelihood area has continued to improve, and the market is expected to stabilize.

The main issues of Beijing's economy are:

(1) High employment pressure

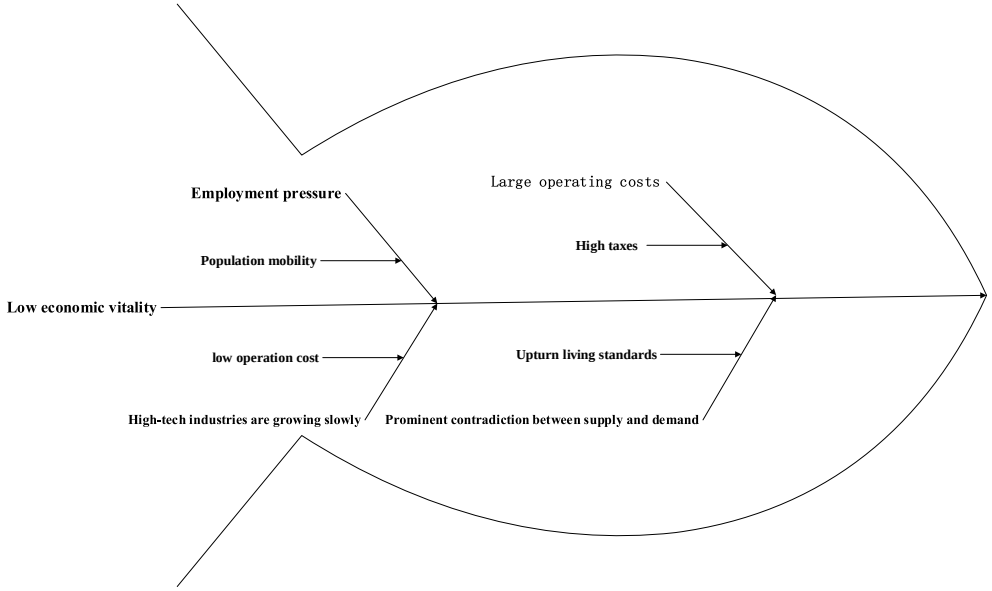
(2) Slow growth of high-tech industry

(3) The widening of regional and urban-rural gap needs to be highly concerned

(4) Enterprise operating costs have risen sharply

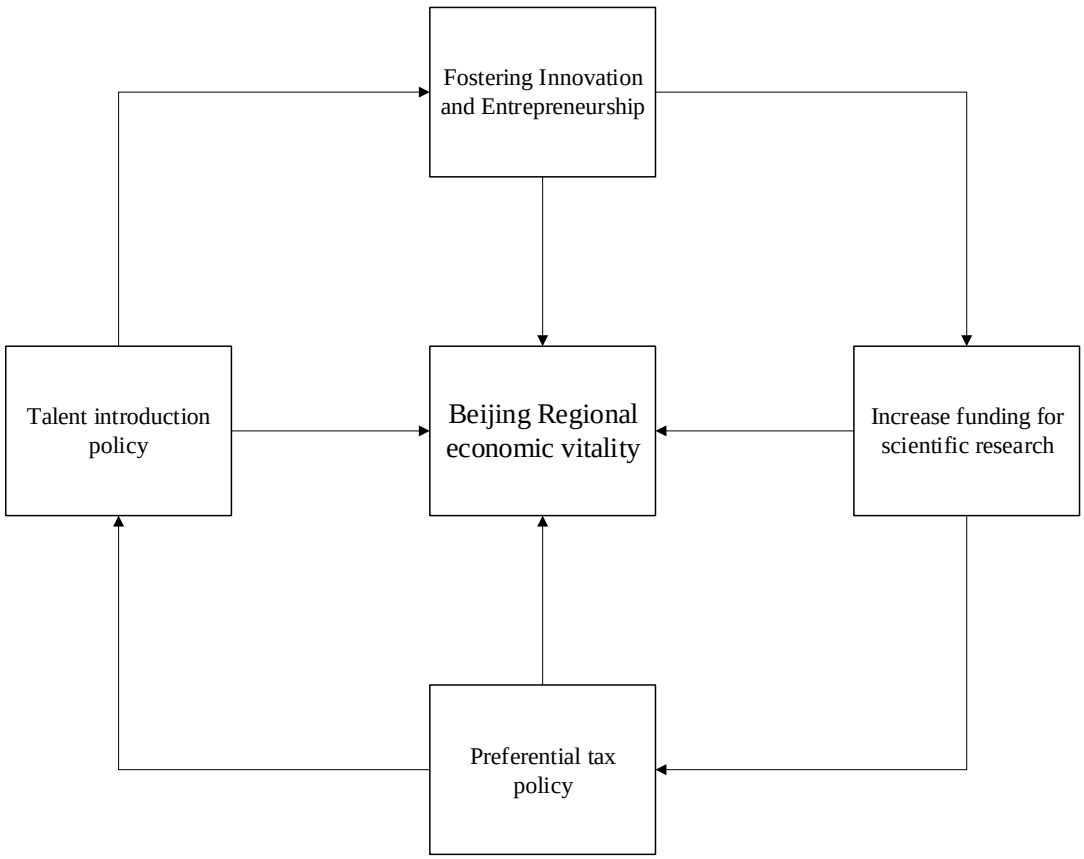
(5) Outstanding contradiction between supply and demand of public goods and services

This can be easily seen from the causal diagram below.



6.2 Development Proposals

According to the regional economic vitality relationship model established in the first question and the mathematical model established in the third question, the influencing factors on urban economic vitality are summarized as follows: per capita GDP, per capita disposable income, per capita fiscal revenue, the proportion of scientific research funding to GDP, the enterprise The actual use of foreign capital for profit, per capita education expenditure; three-year GDP growth rate, per capita disposable income growth rate, fiscal income growth rate; population growth rate, number of enterprises, can be named city size. In the second question, we discussed Beijing The impact of the city's policy of actively promoting the transformation and upgrading of the tertiary industry on the economic vitality of Beijing, but due to the imperfect quantitative standards, we only measure unilaterally with indicators such as the proportion of tertiary industry added value and the tertiary industry contribution rate. The third question is the mathematical model established. We will set up a model for the three problems of investment in scientific research funding, business operating costs, university students' entrepreneurial incentive policies, and children's education of migrant workers.



6.2.1 High-tech development issues

Beijing should continue to increase investment in scientific research funding and increase the proportion of scientific research funding to GDP. The increase in scientific research funding will not only help to promote the in-depth adjustment of the industrial structure and promote economic transformation and development, but also help the city's economic vitality to improve significantly. At the same time, the government should not blindly invest in scientific research funding, but should combine the difficulties existing in Beijing's economic development and industrial development with a purposeful investment in scientific research funding so that more scientific research results can be transformed into the driving force of economic development. According to 2017 In the "Building Plan of Beijing Huairou Comprehensive National Science Center" promulgated in 2006, the mechanism of "opening the walls of the hospital for scientific research" in Beijing will be gradually deepened, and the cooperation between enterprises and scientific research institutions will be closer. We believe that we will continue to implement policies that encourage scientific and technological development. It will have a long-term positive impact on Beijing's economic vitality. At the same time, Beijing should formulate preferential policies to attract high-level foreign scientific researchers to settle down and strive to make Beijing one of the international science and technology centers.

6.2.2 Suggestions on Employment

Beijing should formulate more preferential policies to encourage entrepreneurship, especially for college students. Entrepreneurship is an important driving force for economic development and job creation. As an educational center in China, Beijing has the country's leading innovation ability, and college students also have a huge population base. However, Beijing's housing prices, salary levels, and consumption levels are all in the leading position in

the country, leading to high start-up costs that cannot be afforded by fresh graduates. Therefore, Beijing should formulate policies to encourage entrepreneurship, such as readjustment The loan amount for college students to start a business, etc.

6.2.3 Suggestions on Education

Because of its status as an economic, cultural, and political center, Beijing has attracted a large number of labor forces and caused many social problems that hindered the economic vitality of the city. The education of children of migrant workers is one of them. The complicated formalities required for enrollment, funding for children of special families, promoting fair education, and improving the vitality of the city's economy.

6.2.4 Policy tax advice

Implement tax incentives to encourage and take care of enterprises with poor returns, such as exempting all or part of their taxes payable or returning them in accordance with a certain percentage of their taxes, thereby reducing their tax burden. Support the development of certain special regions, industries, enterprises and products, and promote the adjustment of industrial structure and the coordinated development of society and economy. The members of the group put forward the above four suggestions to improve the economic vitality of Beijing in combination with the actual problems in Beijing.

6.3 Summary:

Beijing's economy has maintained a stable and steady development, and the results of intensive development have gradually appeared, and the quality and efficiency of economic development have continued to improve. The next stage must continue to focus on new development concepts and strategic positioning of the capital city Deepen the supply-side structural reforms, gradually solve the problem of imbalances and inadequacy in development, comprehensively promote high-quality development, and use these measures to enhance economic vitality and promote regional economic development.

Reference

[1] Yi Wei. Construction of evaluation index system for regional economic vitality in Sichuan province [J]. Journal of Sichuan vocational and technical college,2015,25(01):23-25.

[2] He Ruqun. Evaluation of urban economic vitality in the pearl river - Xijiang economic belt [D]. Guangxi normal university,2019.

[3] Chen Junjie, Yao Jinkun. Evaluation of regional economic vitality in western China -- a case study of Sichuan province [J]. Business story,2015(09):51.

[4] Zhang Tingting. Study on spatiotemporal evolution and countermeasures of economic resilience in the Yangtze river delta region [D]. Nanjing normal university,2018.

Appendix

Appendix 1: Grayscale prediction/MATLAB

```
% Grey prediction
clc,clear;
syms a b;
c=[a b]';
a = [253.10,255.90,263.20,275.50,277.90,285.60,289.70,292.60,292.80,293.30];% of the original data
B = cumsum (A);% raw data accumulation
n=length(A);
for i=1:(n-1)
C (i) = (B (i) + B (i + 1)) / 2;% Generate accumulation matrix
end
% Calculate value of pending parameter
D=A;D(1)=[];
D=D';
E=[-C;ones(1,n-1)];
c=inv(E*E')*E*D;
c=c';
a=c(1);b=c(2);
% Predict the follow-up data, predicted ten, can be changed
F=[];F(1)=A(1);
for i = 2: (n + 10)% only guess the last 10 data, you can modify it from here
F(i)=(A(1)-b/a)/exp(a*(i-1))+b/a;
end
G=[];G(1)=A(1);
for i = 2: (n + 10)% only guess the last 10 data, you can modify it from here, change 10 to another number.
G (i) = F (i) -F (i-1);% Get the predicted data
end
disp ('Please enter the original sequence x0');
x0=input('x0=');
x0=x0';
n=length(x0);
x1 = cumsum (x0);% First-order accumulation
for i=1:n-1
z1 (i, 1) = 0.5 * x1 (i) + 0.5 * x1 (i + 1);% let z1 be the next mean series of x1
end
B = horzcat (-z1, ones (n-1,1));% let B be the data matrix
Y = x0 (2: end);% Let Y be a data vector
u = B \ Y% find the parameter vector u, where u (1) is the development coefficient a and u (2) is the ash interaction amount b
y = dsolve ('Dy + a * y = b', 'y (0) = y0');% Solve the gray differential equation
y = subs (y, ('a', 'b', 'y0'), (u (1), u (2), x1 (1)))% substitute the a and b obtained by the above
```

formula into Differential equation
x1_next = vpa (subs (y, 't', n))% Substituting n into y to find x1 corresponding to the next year, x0_next = vpa (x1_next-x1 (n))% Subtract x1 of the previous year from x1_next to obtain x0_next, which is the predicted value for the next year

Appendix 2:BP neural network/MATLAB

```
clear;
clc;
X=-1:0.1:1;
D=[-0.9602 -0.5770 -0.0729 0.3771 0.6405 0.6600 0.4609...
0.1336 -0.2013 -0.4344 -0.5000 -0.3930 -0.1647 -.0988...
0.3072 0.3960 0.3449 0.1816 -0.312 -0.2189 -0.3201];
figure;
plot (X, D, '*');%
net = newff([-1 1],[5 1],{'tansig','tansig'});
net.trainParam.epochs = 100;% maximum number of trainings
net.trainParam.goal = 0.005;% global minimum error
net = train(net,X,D);
O = sim(net,X);
figure;
plot (X, D, '*', X, O);% plot the results and error curves obtained after training (Appendix: 1-2, 1-3)
V = net.iw {1,1}% input layer to middle layer weight
theta1 = net.b {1}% threshold of each neuron in the middle layer
W = net.lw {2,1}% intermediate layer to output layer weight
theta2 = net.b {2}% output neurons
```

Appendix 3:Factor analysis/SPSS

```
dataset activate dataset 0.
GET
FILE = 'C: \ Users \ DELL \ Desktop \ Untitled 1.sav'.
dataset name window = front.
FACTOR
/VARIABLES PerCapitaGDP GDPPerCapitaGrowthRate PerCapitaDisposableIncome
PerCapitaDisposableIncomeGrowthRate PerCapitaRevenue RateOfRDToGDP
RevenueGrowthRate
EnterpriseQuantity TotalProfitsOfEnterprises PopulationGrowthRate ForeignInvestment
PerCapitaExpenditureOnEducation
/MISSING LISTWISE
/ANALYSIS PerCapitaGDP GDPPerCapitaGrowthRate PerCapitaDisposableIncome
PerCapitaDisposableIncomeGrowthRate PerCapitaRevenue RateOfRDToGDP
RevenueGrowthRate
EnterpriseQuantity TotalProfitsOfEnterprises PopulationGrowthRate ForeignInvestment
```

```
PerCapitaExpenditureOnEducation
/PRINT INITIAL CORRELATION KMO EXTRACTION ROTATION FSCORE
/PLOT EIGEN
/CRITERIA MINEIGEN(1) ITERATE(25)
/EXTRACTION PC
/CRITERIA ITERATE(25)
/ROTATION VARIMAX
/METHOD=CORRELATION
```