Team Number :	94801

Problem Chosen :	B

2019APMCM summary sheet

The establishment of the index system of regional economic vitality and its application

How to effectively improve the regional economic vitality is a subject worthy of study. This article takes Hangzhou as an example, and based on the connection between data and actuality, it draws the impact of policy transition on economic vitality, establishes a model to measure regional economic vitality, and proposes Measures to enhance regional economic vitality.

For the first problem: First, collect a large number of indicators on authoritative websites, filter them through factor analysis, and perform stepwise regression on the filtered indicators, so that the influencing factor model is:

$$Y = 3.01016x_1 - 0.112969x_2 + 16.5293x_3 - 2.53662x_4 + 291.574x_5 - 20.9816x_6.$$

Secondly, for the purpose of improving regional economic vitality, based on the above results, three reasonable and feasible action plans were proposed.Finally, the number of population, the number of enterprises, and the regional GDP were analyzed, and the vitality of the population and enterprises was analyzed. Impact on regional economic vitality.

For the second question: Take Hangzhou as an example to interpret the transformation of tourism economic policies and foreign trade economic policies. Use data from 1995-2009 to perform a linear regression on regional economic vitality when no policy is issued, and based on this, 2010-2018 The annual data is substituted to obtain the income or input value under the assumption that the relevant policy is not released. Comparing the actual value with the assumed value, a reasonable policy transition has played a positive role in regional economic vitality.

For the three problem: First, referring to the decomposition of DuPont's analysis system in financial management, the regional economic vitality is expressed by three aspects: capital attractiveness, talent attractiveness, and ecological benefits. Numerical.Finally, the three indicators are added according to certain weights to achieve regional economic vitality comparability. Substituting the values in Annex 3 to obtain the top three cities in order are Beijing, Shanghai, and Shenzhen.

For the four problem: Based on the above results, three Suggestions are put forward for the purpose of making hangzhou have a sound sustainable development ability and strong regional competitiveness.

Key word：Economic vitality active range　Capital attraction　breaking point theory
Gravity model　The index system of economic activity

Contents

I. introduction

1.1Restatement

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.In order to study how to improve the regional economic vitality, we have obtained some data. Please build a suitable model and solve the following problems based on these data and your own data obtained through survey.

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.

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.

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.

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.

1.2 Research background and significance

From an economic perspective, vitality refers to the vigorous vitality of a subject in terms of vitality. For a region, vitality refers to the support of a city, region, or country for vitality, ecology, and economic society. The economic vitality, environmental vitality, social vitality, and cultural vitality together constitute the entire vitality system.

Economic vitality can determine the ability and potential of a country or region's sustained economic growth. From a macro perspective, this ability and potential manifests itself as the ability of economic entities to accumulate, transform, and develop themselves. From a micro perspective, this ability and The potential is represented by the competitiveness of economic entities, the ability to adapt to the market, and the ability to attract economic factors. An analysis and evaluation of the economic vitality of a country or region can accurately locate its current state of economic vitality and have important guiding significance for further stimulating economic vitality.

Regional economic vitality is an important part of regional comprehensive competitiveness, and it is affected by many factors. Quantifying regional economic vitality can intuitively compare the economic competitiveness of each city, and also determine the future development trend of the region How to grasp the key factors and effectively improve the vitality of the regional economy is a subject worthy of study.

II. Problem hypothesis

Hypothesis 1: the data provided in the annex are the data collected at the end of 2018;

Hypothesis 2: there are no man-made statistical errors in the official statistics;

Hypothesis 3: when the data transformation, the default in two decimal places, and rounded.

III. Analysis and model solution of problem 1

3.1problem analysis

Economic vitality refers to the growth rate and potential of total supply and demand in the economy during a certain period of time. Regional economic vitality can reflect the

capacity and potential of urban economic development to a certain extent. For the purpose of improving regional economic vitality, this question Taking Hangzhou as an example, based on the extensive collection of relevant data, an appropriate model is established to analyze it, and based on this, the action plan for improving regional economic vitality is studied. At the same time, referring to the data, the trends of population and corporate vitality are taken as the perspectives Analyze their impact on changes in regional economic vitality. The specific steps are as follows:

Step 1: First, collect a large number of indicators on various websites such as statistical bureaus and statistical yearbooks, and make preliminary selections according to the needs of this question. Second, select the indicators that are initially selected. Factor score coefficients can be given to each indicator through factor analysis. In order to intuitively understand the importance and degree of influence of each indicator. Finally, the relative key indicators obtained by factor analysis are gradually regressioned to obtain a relationship model that affects the regional economic vitality.

Step 2: By referring to the factors influencing regional economic vitality in step 1, analyze and understand them. Based on the purpose of improving regional economic vitality, the paper puts forward reasonable and feasible action plans for different factors.

Step 3: Collect data on the population, the number of enterprises, and the GDP of Hangzhou in a certain period, draw them into a table, and draw a trend chart to facilitate the study of the relationship between the three. Here, this article is based on the literature The trend of borrowing regional GDP indicates the changing trend of regional economic vitality.

3.2 Relational Model of Influencing Factors of Regional Economic Vitality

3.2.1 Model preparation

- Index selection

In the system that analyzes the factors affecting economic vitality, the selected indicators should have the ability to describe, evaluate, and explain, which can fully reflect and reflect the connotation of economic vitality, so as to systematically and accurately understand and grasp the essence of economic vitality. In the selection of specific indicators, the comprehensiveness and scientificity of the indicators should be emphasized, and ambiguity

indicators should be avoided.

In order to achieve a comprehensive quantitative analysis of economic vitality, the selected indicators should be realistic, complete and operable. The characteristics of economic vitality in different stages of economic development and different regions are different, which requires that The selected indicators can comprehensively reflect the main characteristics of economic vitality. Comprehensive reflection does not mean that everything is comprehensive, but focuses on reflecting the main characteristics of economic vitality in combination with various indicators according to the actual situation.

Based on the previous analysis, when constructing an economic vitality evaluation system, this article mainly selects indicators from five aspects: scientific and technological research and development capabilities, capital attractiveness, cultural environment, economic environment level, and social facilities level, and finally selects the number of patent application authorizations (items). , Foreign and Hong Kong, Macao and Taiwan regions' direct investment in China (US $ 10,000), education expenditure (US $ 10,000), financial institution's year-end deposit balance (100 million yuan), net imports and exports (US $ 10,000), railways (US $ 10,000), highways (US $ 10,000) People), water transport (ten thousand people) and invention (one).

- Index screening

Factor analysis refers to the research of statistical techniques for extracting common factors from a group of variables, and its main purpose is to describe some basic, hidden variables that cannot be directly measured, which are hidden in a set of measured variables. The measurement, which can be directly measured, may only be a characterization or a part of it. In this question, the above nine indicators are hidden variables, and regional economic vitality is a characterization.

Factor analysis is performed on each indicator to obtain the factor score coefficients as shown in Table 1. The factor scores can be used to obtain the main indicators of different factors, so that relatively key indicators are selected for model construction based on the importance of these indicators.

Table 1 Factor score coefficient table

variable	Factor 1	Factor 2	Factor 3	Common factor variance
Number of patent applications authorized (item)	0.84	-0.414	-0.096	0.886

Foreign Direct Investment in China from Hong Kong, Macao and Taiwan (10,000 USD)	0.725	-0.663	0.167	0.993
Education expenditure (ten thousand yuan)	0.929	-0.288	0.152	0.968
Deposit balance of financial institutions at the end of the year (100 million yuan)	0.945	-0.299	0.134	1
Net imports and exports (10,000 USD	0.381	-0.922	0.004	0.995
Railway (10,000 people)	0.947	-0.267	0.152	0.991
Highway (10,000 people)	-0.819	0.522	0.070	0.949
Water transport (10,000 people)	0.102	-0.018	0.995	1
Inventions	0.900	-0.369	0.128	0.963
variance	5.5198	2.1137	1.1118	8.7453
Variance contribution rate	0.613	0.235	0.124	0.972

3.2.2 Model construction

Stepwise regression is a method for selecting independent variables of a linear regression model. The basic idea is to introduce variables one by one under the condition that the partial regression square and experience are significant. At the same time, each time a new variable is introduced, the selected regression is selected. The old variables of the model are tested one by one, and the variables that are not considered significant by the test are deleted to ensure that each variable in the obtained independent variable subset is significant. This process goes through several steps until no new variables can be introduced. At this time, the regression model All variables are significant for the dependent variable in.

Aiming at the selection of indicators in the model preparation above, this article performs stepwise regression on the significant factors, and finally obtains the equation as follows:

$$Y = 3.01016x_1 - 0.112969x_2 + 16.5293x_3 - 2.53662x_4 + 291.574x_5 - 20.9816x_6。$$

3.3 Action plan to increase regional economic vitality

Regional economic vitality is represented by the region's economic development and growth capabilities, that is, economic vitality contains two meanings[2]. First, the regional economy should have the ability to attract a certain amount of capital. This ability can be

reflected in human literacy, scientific and technological innovation, and labor. The regional economy should have a good market atmosphere and be able to achieve reasonable allocation and efficient use of resources. The level of regional economic development has a direct determining effect on its economic vitality, and the sustainable development of regional economic vitality has received cultural vitality, environmental vitality, and social vitality. The combined effect of factors.

3.3.1 Improve social security

The development of the economy requires a stable social environment. A complete social security system can reduce the income distribution gap and provide scope for economic development. The social security system is an important policy tool for the government to adjust the income gap and pursue social equity[3]. The establishment of a stable and perfect social security system can Meeting the needs of the people while improving their happiness, thereby stimulating consumption, promoting production, and increasing regional GDP.

The development and improvement of social security should be based on reasonable economic development. First, the speed of social security project expenditures should be controlled and arranged reasonably, and the structure of social security expenditures should be optimized. Second, individuals outside the social security system should be guided to publicize and guide them. In order to make it enter the social security system, in the end, it is necessary to make overall planning and respond with a holistic and long-term perspective to achieve the globalization and integration of the social security system and institutions.

3.3.2 Focus on foreign investment and foreign trade

Foreign investment and foreign trade are not only important indicators to measure the degree of opening up of a city, but also a major source of sustained economic growth. Attracting foreign investment and developing foreign trade are effective ways to achieve a combination of both capital and technology.

In the context of a globalized market, foreign trade has become an important symbol of regional economic vitality.It can also bring advanced technology while bringing capital, and can better participate in the process of globalization. Capital shortage is the main reason restricting economic growth And foreign investment is the main way to improve investment levels.

3.3.3 Improve technological innovation

Since the reform and opening up, a series of major measures to accelerate innovation and development have been proposed one after another, and regional innovation has increasingly become the core of a region's comprehensive competitiveness. The level of technological innovation can not only provide technical support for regional economic development, but also attract high-level economic development outside the region. Quality production factors, thereby promoting the development of regional economies. Governments in developed countries often formulate a large number of related policies to encourage technology, and provide financial support for many basic and applied research.

There is a coupling relationship between the two complex social systems, regional innovation and regional economy. On the one hand, regional innovation can directly promote the expansion of the economic scale and also promote economic stability. On the other hand, the enhancement of regional economy can also be a regional innovation. Invest more money to provide it with environmental support.

3.4 Trends in population and business vitality to see regional economic vitality

The vitality of a city's economy can be expressed in terms of economic growth, foreign capital, and the attractiveness of various factors of production.It can reflect the current development status and future development prospects of the city from the average price.

The number of enterprises is an important indicator of regional economic vitality. The number of registered enterprises and registered capital in a city is closely related to the economic vitality and population size of the city. The contribution of enterprises to the economy is not limited to direct output value and taxation, but also to the city's economy. The formation of vitality, capital and talent absorption capacity also has an indirect effect. The number of enterprises directly affects the available job opportunities, thereby affecting the city's resident population, and can also largely promote resource recycling and determine economic benefits. As a market The microcosmic body of economic operation, the operation of the enterprise involves various production factors such as entrepreneurs' capabilities, capital, land, manpower, and technology, which determine the performance and further development of the enterprise. Therefore, the regional economic vitality and urban There is a correlation between changes in the number of permanent residents and the vitality of enterprises[1].

The growth rate of GDP is generally used to measure economic growth rate, it is a

dynamic indicator reflecting the degree of change in the level of economic development in a certain period, and it is also a basic indicator reflecting whether a country's economy is dynamic. Similarly, this article borrows regional production here. The trend of the total value reflects the trend of regional vitality. This question obtains the table 2 by collecting and statistics on the three types of indicators: the population, the regional GDP, and the number of enterprises in each year at the end of Hangzhou.

Table 2 Population, GDP and number of enterprises in each year from 2011 to 2018

years	Population at the end of the year (10,000 people)	Regional GDP (100 million yuan)	enterprise
2018	774.1	13509.2	487000
2017	753.88	12603.36	414208
2016	736	11313.72	364388
2015	723.55	10050.21	312334
2014	715.76	9206.16	273734
2013	706.61	8343.52	232928
2012	700.52	7802	197973
2011	695.71	7019.06	185727

In order to study the change relationship between the three, you can draw a trend chart to observe their trend. Due to the difference between the indicator unit and the digital scale, this article standardizes the data here.

Data standardization is to scale the data so that they fall into a small specific interval. This question can be used to remove the unit limitation of the data by means of data standardization and convert it into a dimensionless pure value, which is convenient for the trend comparison between different indicators. Therefore, this paper chooses the most typical data normalization processing, that is, the data is uniformly mapped to the [0,1] interval. This method is also called dispersion standardization, which is a linear transformation of the original data, and the result falls to [0, 1] interval, the conversion function is shown in formula (1).

$$x^* = \frac{x - min}{max - min} \quad (1)$$

Where max is the maximum value of the sample data, min is the minimum value of the sample data, and the final result is shown in Table 3.

Table 3 The normalized index value

	Population at the end of the year (10,000 people)	Regional GDP (100 million yuan)	enterprise
2018	1.00	1.00	1.00
2017	0.74	0.86	0.76
2016	0.51	0.66	0.59
2015	0.36	0.47	0.42
2014	0.26	0.34	0.29
2013	0.14	0.20	0.16
2012	0.06	0.12	0.04
2011	0.00	0.00	0.00

Based on the data in the above table, a trend chart is drawn based on the data (see Figure 1). Observation shows that the three trends are similar, and all of them have an upward growth trend over time. It can be seen that the regional economic vitality is closely related to the population and the number of enterprises.

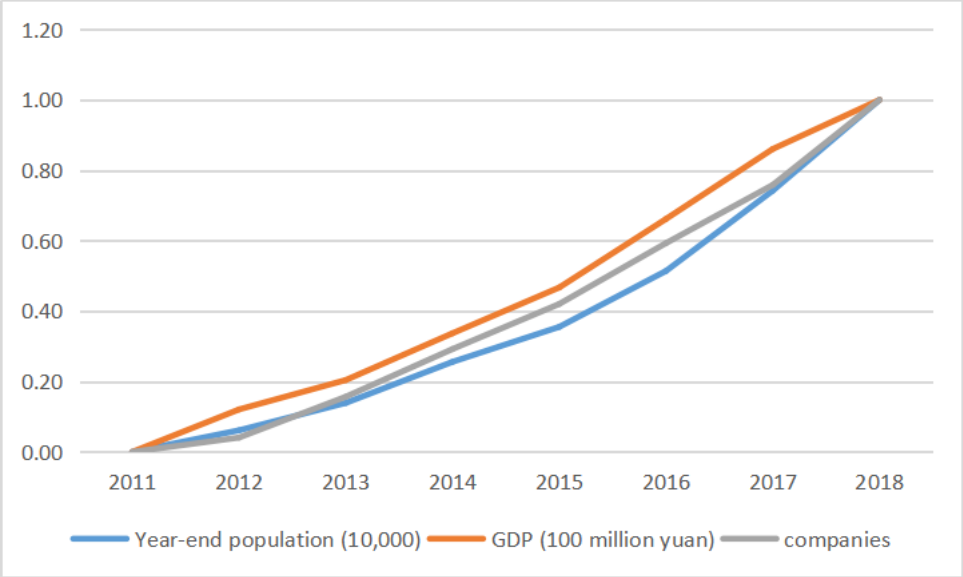


Figure 1 Trends in the number of enterprises, population and GDP

IV. The solution of problem 2 (taking two kinds of policies as examples)

4.1 problem analysis

Economic policy transformation refers to changes in resource allocation and economic development methods, including changes in development models, development factors, and development paths.For the purpose of studying the long-term and short-term effects of economic vitality, this question uses Hangzhou as an example to collect relevant economic Based on policies and data, a reasonable analysis and expansion are carried out to obtain the impact of specific economic policy transitions on Hangzhou. The specific problem-solving steps are as follows:

Step 1: Extensive collection of economic policy measures through website platforms such as Hangzhou government agencies, Hangzhou political party agencies, etc., and preliminary screening of them according to the needs of this question.

Step 2: On the Hangzhou Statistics Bureau, Hangzhou Statistical Yearbook, and Hangzhou Statistical Bulletin, collect relevant indicator values of relevant policies and import them into Excel for preliminary data collation and mapping.

Step 3: On the basis of data collation, use python to make regression predictions for each indicator value, and compare the economic vitality of the region before and after the transition, so as to realize the purpose of intuitively understanding the long-term and short-term impact of economic policy transition on Hangzhou's economic vitality.

4.2 Data screening

When faced with the choice of economic policy, the selected data should be officially authoritative to avoid the problem of unfounded data, so as to provide data support for the subsequent model establishment. Therefore, in terms of data selection, this article will Hangzhou Authoritative data released by government agencies and Hangzhou political party agencies serve as the direction of data selection[4].

Based on the analysis results of Question 1, this article takes the tourism economy and foreign-invested economy as examples to analyze the long-term and short-term effects of

these two economic policy transitions on Hangzhou's economic vitality.

4.3 Interpretation of Two Policy Transformations

4.3.1 Tourism Economic Policy Transformation

In 2010, facing the complex and severe situation at home and abroad, the unfavorable comprehensive environment for tourism development, and the increasing pressure on industrial structure adjustment, China has been encouraging to build an internationally important tourism and leisure center tourism system for key tourist cities, implementing tourism internationalization, and tourism. Globalization strategy, stable and healthy development of tourism economy.

Since ancient times, Hangzhou has had the reputation of "upper heaven, lower Suzhou and Hangzhou". Since 2010, Hangzhou has improved Hangzhou tourism projects in response to the "State Council's Notice on Further Accelerating the Development of Tourism". Specific transformation measures as follows:

(1) Protect the natural ecological environment or a large area of green land, and allow the land that is not engaged in capital construction to be directly supplied by the collective land owner in the form of agricultural land lease;

(2) Allow the owner of the land and the investor or entrepreneur to set up a project company for joint development, and give a certain degree of help;

(3) The forest and green land for key large-scale tourism projects that have been introduced can be provided for land in the same period or leased;

(4) Under the premise of well-controlled detailed regulations, the completed tourism, leisure and holiday development block will be open for investment promotion, and select the best investors.

4.3.2 Foreign economic policy transition

In 2010, according to the needs of economic development and the diversification of foreign investment methods, Hangzhou rationally adjusted the foreign investment structure. By using the overseas capital market to deepen the foreign investment management system and create a good foreign investment environment. Several Opinions on Work policy,

Hangzhou's specific transformation measures are as follows:

(1) Fully understand the significant strategic significance of using foreign capital, and clarify that foreign capital is an important carrier for introducing international advanced ideas, high-end talents and modern business models;

(2) A deep understanding of foreign investment is an important way for Hangzhou's economic transformation. Through the introduction of "three high" technologies, Hangzhou's local high-tech technology is improved;

(3) To further improve the overall level of foreign investment, seize important strategic opportunities, and vigorously implement the strategic construction of "big platforms, big industries, big projects, and big enterprises";

(4) Clarify the overall goals, maintain the quality and level of utilizing foreign capital, and ensure that the economy develops to a high-end, innovative, and practical.

4.4 Establishment of regression prediction model

Linear regression is a statistical analysis method that uses regression analysis in mathematical statistics to determine the quantitative relationship between two or more variables.It is widely used. Univariate linear regression analysis includes only one independent variable and one factor. Variables, and the relationship between the two can be approximated by a straight line.

Based on the basic principle of linear regression estimation, this question takes year as the independent variable and tourism income as the dependent variable, and establishes a linear regression model.The specific formula is shown in formula (2).

$$y = ax + b + \varepsilon \quad (2)$$

among them a=Regression coefficient,b= Intercept, ε =residual. The output value y is the predicted value, that is, if the policy is not implemented, the income value for the corresponding period.

Call the data from 1995 to 2009, and encapsulate it with python. After encapsulation, call the pandas library and the sklearn library and substitute them into the dependent and independent variables to obtain the regression equation:

$$y = 48.16x - 96071.28$$

Based on the regression equation, the data from 2010 to 2018 is substituted to obtain the

predicted value of the unissued policy y (see table 4), and the specific code is shown in the appendix .

Table 4 The actual value and Predictive value

year	The actual value	Predictive value
2018	3589.1	1226.63
2017	3041.34	1178.46
2016	2571.84	1130.29
2015	2200.67	1082.13
……	……	……

The data in the above table is plotted into a trend chart (see figure 2). It can be seen from the observation that if this policy is not released, the tourism economy will rise, but the increase is far less than that of the released policy. It can be seen that its economic policy has been transformed The tourism economy of Hangzhou has a great influence.

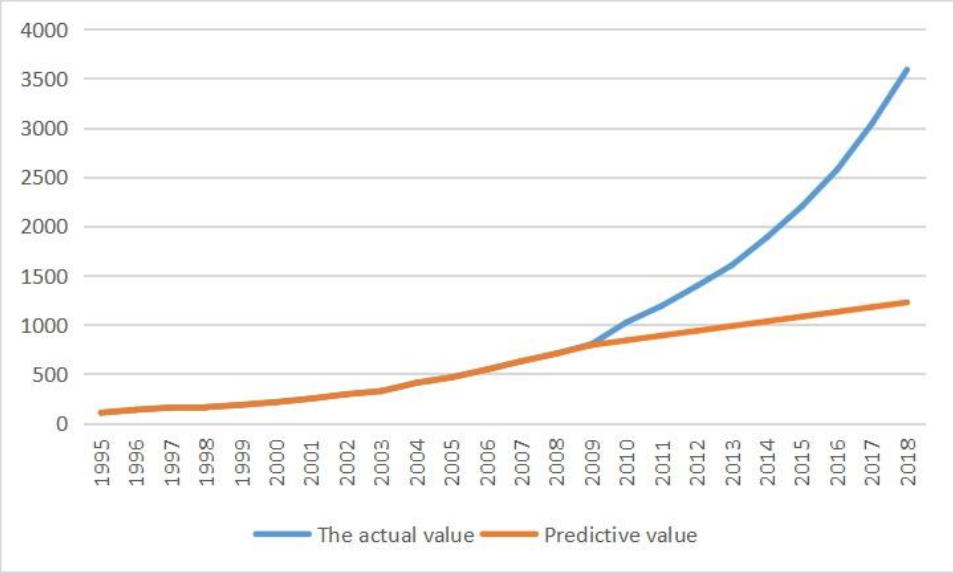


Figure 2 Trend chart

According to the above method, the data of foreign investment is substituted into the model for the same reason, and the regression equation is obtained as follows:

$$y = 883.15x - 1763128.75$$

Based on the regression equation, the data from 2010 to 2018 is substituted to obtain the

predicted value y of the unissued policy (see table 5).

Table 5 Foreign investment and Predictive value

year	Foreign investment (100 million yuan)	Predictive value
2018	478.99	424.84
2017	463.56	407.93
2016	505.58	391.01
2015	498.80	374.10
……	……	……

The data in the above table is drawn into a trend chart (see figure 3). It can be seen from observation that if this policy is not released, foreign investment capital will rise, but the increase is far less than the situation of the policy is released. It can be seen that its economic policy The transformation of Hangzhou's foreign investment capital has a great impact.

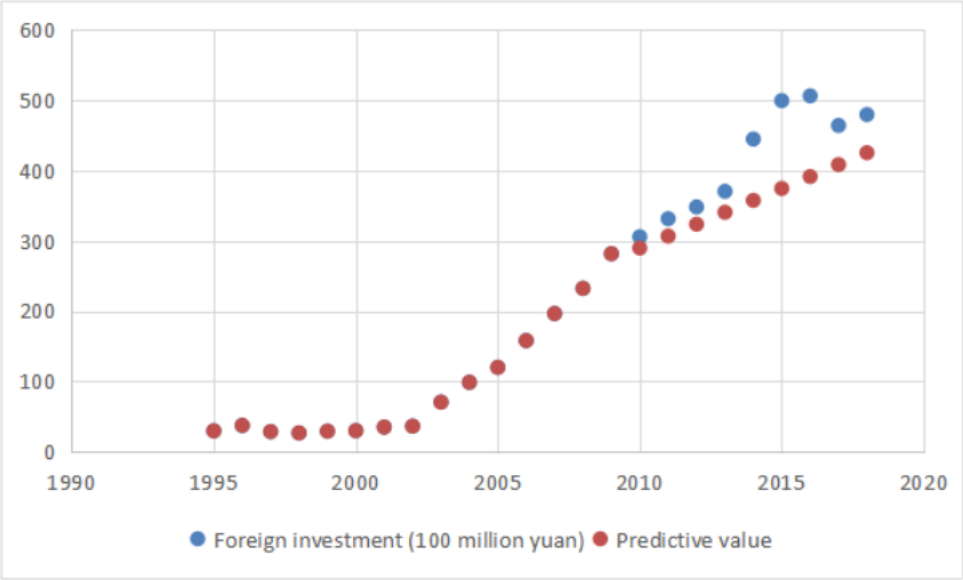


Figure 3 trend chart

4.5 Long-term and short-term effects of two economic policy transitions

In the short term, although the policy promulgation has played a significant role in the regional economic vitality of Hangzhou; in the long term, the two policies still provide great

financial support to stimulate local economic effects.

Foreign investment has driven the development of local high-tech enterprises and stimulated the emergence of new industries; the other part has solved the serious employment and wage problems in cities. At the same time, more companies and talents are willing to come under the attraction of foreign investment. The development of Hangzhou. The development of tourism has promoted the establishment and awareness of environmental protection awareness of local citizens in Hangzhou to a certain extent, and the improvement of Hangzhou's social infrastructure. At the same time, it has guaranteed the good life of local people in Hangzhou and promoted the healthy consumption of all classes.

V. Analysis and model establishment of Problem 3

5.1 Problem analysis

Step 1: referring to the decomposition thought of dupont analysis system in financial management, the regional economic vitality is gradually decomposed into several aspects;

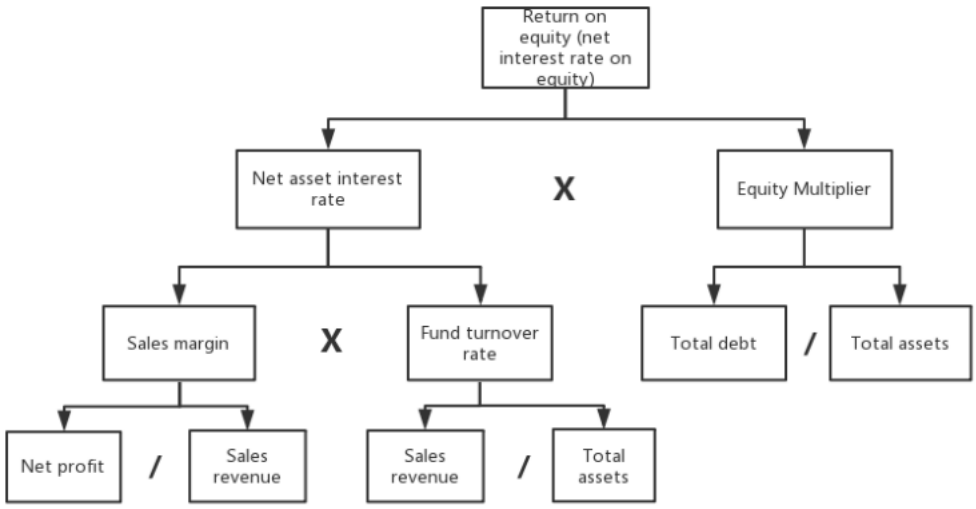
Step 2: second decomposition of different aspects to obtain a regional economic vitality evaluation system similar to dupont analysis system;

Step 3: assign values to different indicators and give them certain weights. Substitute them into the regional economic vitality system to get the regional economic vitality value, and then compare them to get the ranking of regional economic vitality.

5.2 Model framework based on DuPont analysis system

The DuPont analysis system is a comprehensive systematic analysis and evaluation of the financial status and economic benefits of enterprises by using the internal relationships between the main financial ratio indicators. Its most significant feature is the use of the idea of hierarchical decomposition and the net assets according to its internal connections. The rate of return is comprehensively reflected through several financial ratios used to evaluate the business performance of the enterprise, forming a complete and concise indicator system structure. Through this method, the level of comprehensive analysis of financial ratios is

clearer, more organized, and it is also a statement analyst A comprehensive understanding of the company's operating conditions provides an effective way. The DuPont analysis system is shown in Figure .



This question studies a mathematical model system for measuring regional economic vitality. Here, this article takes the DuPont analysis system as the basic blueprint and uses a stepwise decomposition method to disassemble the regional economic vitality into a number of indicators. On the basis of consulting the literature and reference data This article will measure regional economic vitality from three aspects: capital attractiveness, talent attractiveness, and ecological benefits.

5.3 Model establishment

- Capital attraction

Based on the analysis above, the ability to attract funds in the region cannot be separated from the economic development, investment returns, and cultural environment in the region. Therefore, this article breaks down the attractiveness of funds based on this and proposes the following three indicators:

$$\text{The financial contribution}=\frac{\text{Ending balance of financial institutions}}{\text{Regional GDP}};$$

$$\text{Investment absorption rate}=\frac{\text{Foreign direct investment in the region}}{\text{Regional GDP}};$$

$$\text{Cultural exchange rate}=\frac{\text{Total tourism revenue in the region}}{\text{Regional GDP}}.$$

The introduction of these three indicators makes the factors that affect the attractiveness of funds look more intuitive, and can analyze the attractiveness of funds from more detailed aspects.

- Talent attraction

Talents play a vital role in the economic development of the region, and the increase of talents can promote economic development. The state usually formulates relevant policies to improve the treatment of talents, so as to achieve the effect of talent cultivation and attract more talents. The education guarantee is also an important factor affecting the quantity and quality of talents, and good education guarantees are often linked to the vitality of regional talents. In view of the attractiveness of talents, this article breaks them down into the following two indicators:

$$\text{Per capita income}=\frac{\text{Regional GDP}}{\text{At the end of regional population}};$$

$$\text{Security of education}=\frac{\text{Regional GDP}}{\text{Regional finance for education spending}}.$$

- Ecological Benefits

The economic vitality of a specific region is inseparable from the development of the social ecological environment and infrastructure construction.Here, this article proposes a characteristic index of environmental protection rate and the construction of environmental leverage to quantify ecological benefits.

$$\text{Environmental protection degree}=(\text{Regional GDP})\times(\text{The greening area coverage});$$

$$\text{The environment of lever}=\text{Annual regional PM2.5 concentrations}.$$

Based on the calculation results of these three broad categories of indicators, because economic development is the basis of comprehensive regional development, this article sequentially positions the weight of funds attractiveness indicator, talent attractiveness

indicator, and ecological benefit indicator at 40%, 30 %, 30%.

Therefore, the indicator system equation is:

$$\text{Economic vitality} = 40\%\text{Capital attraction} + 30\%\text{Talent attraction} + 30\%\text{Ecological benefits}$$

The visual system diagram is shown in Figure 4 .

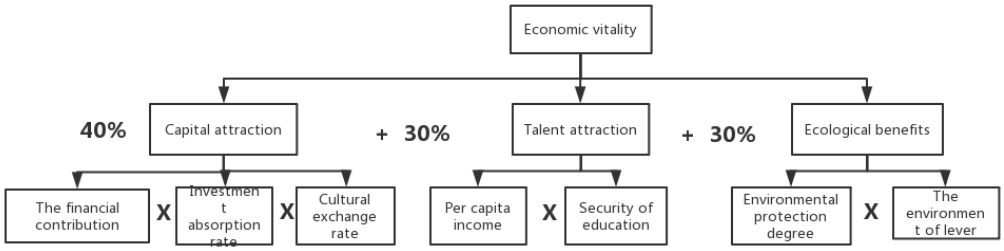


Figure 4 The visual system diagram

5.4 Results display

Through this indicator system, each city in Annex III will be evaluated and scored, and the relevant data will be substituted to obtain the regional economic vitality value. The specific ranking results are shown in Table 6:

Table 6 Economic vitality and Ranking

city	Economic vitality	Ranking
Beijing	2965.678677	1
Shanghai	2716.646026	2
Shenzhen	2142.660495	3
Tianjin	2140.31263	4
Guangzhou	2020.780895	5
Chongqing	1790.815396	6
Wuhan	1411.739577	7
Qingdao	1232.80575	8
Nanjing	1152.753366	9
Hangzhou	1117.387882	10
Chengdu	1116.933096	11
Changsha	1111.192563	12
Ningbo	1095.149283	13
Suzhou	1086.295103	14
Zhengzhou	974.748243	15

Shenyang	892.1589247	16
Dongguan	876.8278661	17
Xi'an	777.740845	18
Kunming	527.1267744	19

Taking Hangzhou as an example, a trend chart of the regional economic vitality value for ten years (see figure 5) shows that the regional economic vitality in Hangzhou has shown an upward trend in the past ten years.

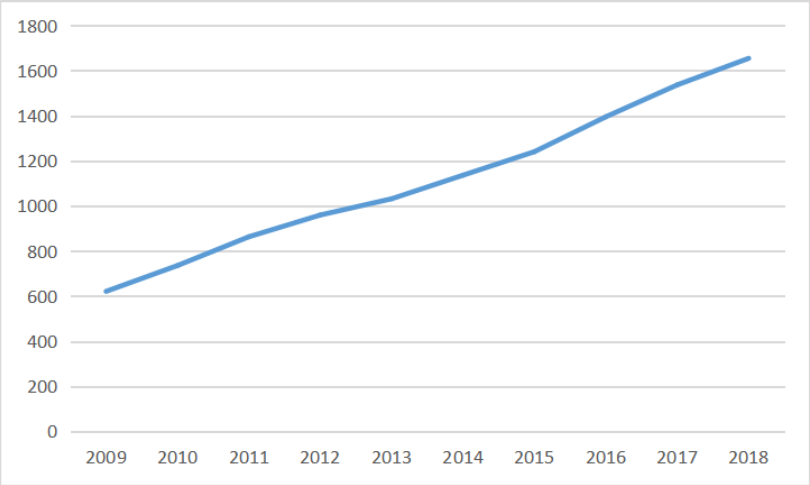


Figure 5 trend chart of the regional economic vitality value

VI. Analysis of problem number four

Based on a large number of statistics in this paper, it is found that hangzhou does not rank very high among the 18 cities. According to the conclusions of questions 1-3, it can be concluded that economic development is the fundamental factor to promote regional economic vitality, while scientific and technological innovation and social infrastructure are secondary factors.

Therefore, hangzhou should make the following changes in order to make the regional economic vitality have the ability of benign sustainable development and strong regional competitiveness:

1. vigorously introducing foreign capital and rationally allocating foreign investment. On this basis, we will strengthen the policy of providing high assistance, high support and high welfare to high-tech innovation and entrepreneurship companies, so as to improve the talent retention rate.

2. Through the improvement of urban service construction and the improvement of local green coverage rate, residents' quality of life can be improved and residents' better life can be guaranteed, so as to stimulate people's desire to live to a certain extent.

3.increase spending on education and scientific research. Innovation and talents are the main driving forces for sustainable economic development. Higher education expenditure can promote students' humanistic quality in universities and colleges and ensure the high-quality and high-level growth of talents. The increase of expenditure on scientific research can improve the level of each scientific research technology in hangzhou and promote the international development of scientific research technology.

VII. Model to improve

In order to further optimize the index of capital attractiveness, this paper proposes the theory of the breakpoint of the interaction of economic vitality between cities to redefine the attractiveness of urban capital and delineate the active economic vitality zone.

Breakpoint theory is a theory about the interaction between cities or regions, which was developed by Comvis on Rayleigh's law of retail gravity. The theory believes that a central city can have a profound impact on the development of adjacent areas At the same time, its influence on the total amount of these regions is unequal. Due to the differences in the size of cities (such as population size, economic size, etc.), the scope of their effects is different. The impact gradually diminished and was eventually replaced by the impact of other nearby cities.

First assume that there are two regional central cities i and jC located somewhere between them.The capital attraction of central cities i and j to c is obtained by the gravitational formula:

$$F_{\text{Capital attraction}} = K_{\text{The weight}} \times \frac{M_i M_j}{r^2}$$

Where M_i Economic indicators (GDP, financial institution year-end balance) of city i, M_j Economic indicators (GDP, financial institution year-end balance) of city i; $K_{\text{The weight}}$ Spells determined for experience (40%); r is the distance between two cities (km); $F_{\text{Capital attraction}}$ Is the gravitational value sought.

Assume that the attractiveness of cities i and j in a region e is equal, and this region is defined as the breaking point of attraction of urban capital. Based on this, we can get the formula:

$$K_{\text{The weight}} \times \frac{M_i M_e}{r_i^2} = K_{\text{The weight}} \times \frac{M_j M_e}{(r_{ij} - r_i)^2}$$

Finishing can be obtained:

$$r_i = \frac{r_{ij}}{\left(1 + \sqrt{\frac{M_i}{M_j}}\right)}$$

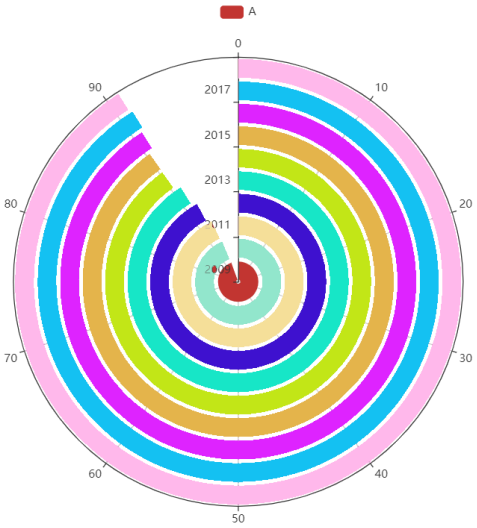
Where: r_i Represents the distance (km) from the breaking point to the city i, r_{ij} Distance between city i and city (km)

M_e Economic indicators (GDP, financial institution end-of-year balance) representing area e

Take Hangzhou and Ningbo as examples to calculate the break point of capital attraction, that is, the active range of the city's economic vitality.

Breakpoint of Fund Radiation Attraction				
City i Hangzhou	Distance from breaking point to Hangzhou (km)		Distance from breaking point to Ningbo (km)	
	Gdp by region	Balance of local and foreign currencies at the end of the financial institution	Gdp by region	Balance of local and foreign currencies at the end of the financial institution
2018	84.88	94.48	75.12	65.52
2017	84.92	93.82	75.08	66.18
2016	85.28	93.38	74.72	66.62
2015	84.55	92.17	75.45	67.83
2014	83.80	91.23	76.20	68.77
2013	83.15	90.32	76.85	69.68
2012	83.40	90.34	76.60	69.66
2011	82.94	90.85	77.06	69.15
2010	82.83	91.13	77.17	68.87
2009	83.27	90.93	76.73	69.07

The economic vitality radiating interval of Hangzhou has been expanding through the ten-year launch:



Through the improvement of the index of capital attraction by the gravity model, it is not difficult to observe the radiation range of ten years' economic activity in hangzhou and ningbo to find that the active radiation area of hangzhou is expanding continuously and the economy is developing rapidly, which is in line with the reality, and the measurement accuracy is greatly improved. Conducive to follow-up research.

VIII. Reference

[1] Zhang Keyuan. Analysis on the status quo of urban vitality development in Beijing-Tianjin-Hebei based on corporate influence [j]. Industry and Science Forum, 2019, 18 (16): 87-88.

[2] Zhang Hongdong, Qin Zhenyan. Analysis on the composition of urban economic vitality [j]. Heilongjiang Science and Technology Information, 2011 (21): 155.

[3] Cao Haitao. On the relationship between social security and economic development [j]. International Public Relations, 2019 (11): 294.

[4] Li Yaoting. Research on the development of urban tourism industry [d]. East China Normal University, 2013.

IX. Appendix

Question one

```
function [ G ] = GM( A,num )
```

```
% Gray prediction model function Lan Yong, 2018.7.20
% A is the original sequence, num is the number of predictions, and G is each prediction value

syms a b;
c = [ab] ';% development coefficient and ash effect
B = cumsum (A);% generate accumulation sequence
n=length(A);

for i=2:n
    P (i) = A (i) / B (i-1);% smoothness test
    Q (i) = B (i) / B (i-1);% quasi-exponential test
end

for i=1:(n-1)
    C (i) = (B (i) + B (i + 1)) / 2;
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);
% Forecast follow-up data
F=[];F(1)=A(1);
for i = 2: (n + num)%
    F(i)=(A(1)-b/a)/exp(a*(i-1))+b/a;
end

G=[];G(1)=A(1);
for i = 2: (n + num)% num original sequences after speculation
    G(i)=F(i)-F(i-1);
end

% Residual calculation
for i = 1: n num original sequences after speculation
    s(i)=abs(A(i)-G(i));
end
sum(s)/n;

% Image visualization
```

```
t1=1:n;
t2=1:n+num;
G;
h = plot (t1, A, 'o', t2, G, '-');% Comparison of original data and predicted data
set(h,'LineWidth',1.5);

End
```

Grey forecasting model inserts 2016-2018 vacancy value for railway passenger volume

```
A=[2494.88 2474.34 2961.95 3112.38 3717.04 4688.88 5282.37];
GM(A,3)

ans =

     1.0e+03 *

   1 to 7 columns

      2.4949       2.4046       2.8131       3.2910       3.8501       4.5041       5.2692

   8 to 10 rows

      6.1643       7.2114       8.4364
```

Gray prediction model inserts 2016-2018 vacancy annual value for railway freight volume

```
A=[426.75 276.24 273.54 239.23 211.15 191.94 168.48];
>> GM(A,3)

ans =

      5.0866


ans =

   1 to 7 columns

   426.7500   287.4766   259.8881   234.9472   212.3999   192.0163   173.5889

   8 to 10 rows

   156.9300   141.8698   128.2548
```

Load and common factor variance after rotation

Varimax rotation

Variable factor 1 factor 2 factor 3 common factor variance
Number of patent applications authorized (items) 0.840 -0.414 -0.096 0.886
Foreign Direct Investment in China from Hong Kong, Macao and Taiwan (US $ 10,000) 0.725 -0.663 0.167 0.993
Education expenditure (ten thousand yuan) 0.929 -0.288 0.152 0.968
Deposit balance of financial institutions at the end of the year (100 million yuan) 0.945 -0.299 0.134 1.000
Net imports and exports (US $ 10,000 0.381 -0.922 0.004 0.995
Railway (10,000 people) 0.947 -0.267 0.152 0.991
Highway (10,000 people) -0.819 0.522 0.070 0.949
Water transport (10,000 people) 0.102 -0.018 0.995 1.000
Invention (number) 0.900 -0.369 0.128 0.963

Variance 5.5198 2.1137 1.1118 8.7453
Variance contribution rate 0.613 0.235 0.124 0.972

Factor score factor

Variable factor 1 factor 2 factor 3
Patent application authorizations (items) -0.002 -0.008 0.000
Foreign and Hong Kong, Macao and Taiwan direct investment in China (10,000 USD) -0.044 -0.137 0.002
Education expenditure (ten thousand yuan) 0.000 0.002 -0.000
Deposit balance of financial institutions at the end of the year (100 million yuan) 1.263 0.591 -0.119
Net imports and exports (US $ 10,000-0.368 -1.153 0.017
Railway (10,000 people) 0.008 0.024 -0.000
Highway (10,000 people) 0.007 0.023 -0.000
Water transport (10,000 people) -0.163 -0.056 1.021
Invention (number) -0.005 -0.016 0.000

Pass the above results

Step by step regression

A = xlsread ('Experiment.xlsx', 'A2: K11');
>> Y=A(:,1)

Y =

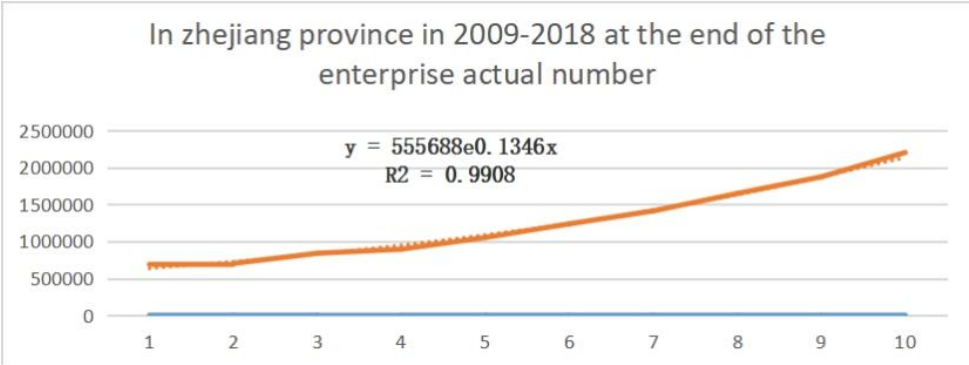
152436
155457
185727
197973
232928
273734
312334
364388
414208
487000

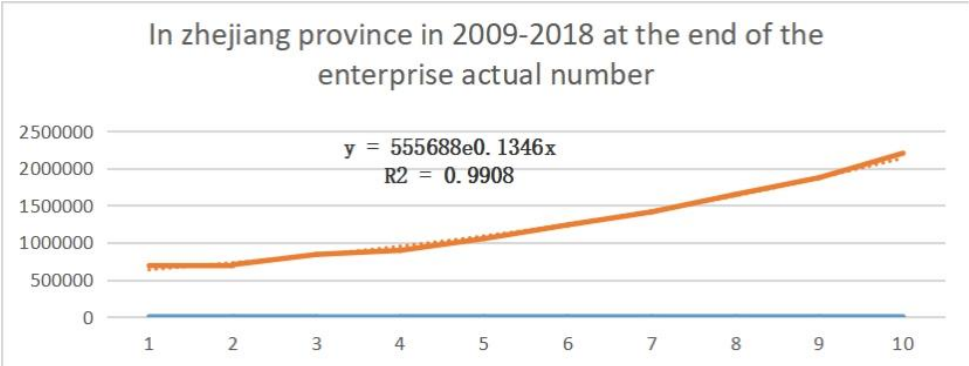
>> X = xlsread ('Experiment.xlsx', 'B2: K11');
>> stepwise(X,Y,[1:1:10],0.05,0.10)
Representing y's economic vitality and x [patent application authorizations (items) x1, foreign direct investment in Hong Kong, Macao and Taiwan regions (US $ 10,000) x2, financial institutions' year-end deposit balance (100 million yuan) x3, transportation passenger volume (x4, x5), invented (a) x6] The fitted model is better
R≈0.998 P<0.05

Question two

```
import pandas as pd

import numpy as np

import matplotlib.pyplot as plt

from pandas import DataFrame,Series

from sklearn.cross_validation import train_test_split

from sklearn.linear_model import LinearRegression

cc1 = pd.read_excel ("Travel.xlsx")

import statsmodels.api as sm

linreg = LinearRegression()

x=cc1.iloc[:,1]

y=cc1.iloc[:,0]

x=np.array(x).reshape(-1,1)

y=np.array(y).reshape(-1,1)

z=[]
```

```
for i in range(10):
    z.append(i+2011)


z=np.array(z).reshape(-1,1)
model=linreg.fit(y,x)
xx=model.predict(z)
a = model.intercept_ # intercept
b = model.coef_ # regression coefficient
print ("Best fit line: intercept", a, ", regression coefficient:", b)
```





Model improvements:

Hangzhou	Foreign currency (100 million yuan)	GDP
2018	39810.5	13509.20
2017	36483.24	12603.00
2016	33386.04	11313.72

2015	29863.83	10050.21
2014	24450.51	9206.16
2013	22174.71	8343.52
2012	20148.77	7802.01
2011	18396.57	7019.06
2010	17084.35	5949.17
2009	14284.21	5100.00

Distance between cities	160km	
Ningbo	Foreign currency (100 million yuan)	GDP
2018	19150	10579.51
2017	18149.1	9850.00
2016	16989.3	8686.4911
2015	16175.3	8003.6103
2014	13890.1	7610.2816
2013	13200	7128.8672
2012	11980.5	6582.2064
2011	10659.3	6059.2409
2010	9755.5	5163.0017
2009	8241.4	4329.3025