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Evaluation of Economic Vitality of Beijing and Analysis of Influencing Factors

—Based on Entropy Method and Grey Correlation Analysis Model

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Abstract

Based on the time series data related to the economic vitality of Beijing from 2013 to 2017, a suitable evaluation system for urban economic vitality is established from the perspective of economic growth, enterprise vitality, capital capacity and labor quality. The entropy method was used to evaluate the urban economic vitality of Beijing, and the grey correlation analysis was used to explore the influence of enterprise vitality and the change of urban resident population on the urban economic vitality. The results show that: First, the economic vitality of Beijing's urban economy increased year by year in 2013-2017, and the growth rate increased significantly between 2016 and 2017. Second, the grey correlation degree between enterprise vitality and population quantity and urban economic vitality is high, enterprise vitality includes the number of enterprise registration and the total enterprise profit son-in-line correlation. In view of the conclusion of the study, it is suggested that various places can promote the economic vitality of the city by enhancing the vitality of enterprises and attracting the influx of talents.

Keywords

Urban Economic Vitality, Business Registration, Entropy Method, Grey Correlation Analysis

1. Introduction

"Economic vitality" refers to the growth rate and development potential of a country's aggregate supply and demand in a certain period of time. To narrow it down to regions is to show the development of an area. Urban economic vitality refers to the ability and potential of a city in the process of economic develop-

ment, representing the comprehensive level of a city. The urban economic vitality is mainly manifested in the growth and sustainable development of the city, and more in the growth of the economy, the attraction to various factors of production and foreign capital. In order to fully implement the spirit of the 19th CPC National Congress, promote the construction of smart cities, promote the coordinated development of cities and enhance the economic vitality of cities, all provinces and cities have adopted corresponding policies and measures. This paper studies the development and changes of Beijing's urban economic vitality and competitiveness, which can be used as a reference for the growth of other provinces and cities, especially the cities with backward peripheral development.

At present, the domestic scholars have made some research on urban economic activity. In terms of evaluation of urban economic vitality, Jin Yan-Jie took economic aggregate and growth rate, enterprise income, resident income, financial revenue and expenditure and social security, foreign trade and foreign capital, education and technology level and environmental protection as evaluation criteria, using the factor analysis method to the national important 50 cities in urban economic vigor index of quantitative study (Jin, 2007). Zhang Hong-Dong and Qin Zhen-Yan also discussed the composition of urban economic vitality from seven aspects of Jin Yan-Jie's research (Zhang & Qin, 2011). In terms of influencing factors of urban economic vitality, Zhang Ke-Yuan used grey correlation measure to measure the correlation between the number of urban enterprise registrations and the registered capital on the resident population in the Beijing-Tianjin-Hebei region, and concluded that enterprises have a significant impact on the economic vitality and population size of the cities where they are located (Zhang, 2019). Liu Jia made an in-depth analysis of the relationship between urban economic vitality and business tourism, and put forward countermeasures and suggestions on how to develop business tourism in cities (Liu, 2006). In terms of the research of urban vitality improvement path, Chen Yuan-Chong and Niu Jun-Wei explored the traditional source of urban vitality, analyzed the requirements of modern transformation of urban vitality elements, and proposed suggestions for urban vitality construction in Zhangzhou city, Fujian Province (Chen & Niu, 2019). Sun Jing combined aging population with urban vitality, and proposed to improve the old-age service system, improve the old-age care system, and improve urban vitality (Sun, 2014).

Most of the existing literatures qualitatively analyze the influencing factors of urban economic vitality or evaluate the urban economic vitality with PCA method, but there are few researches on the quantitative influence degree of specific factors of urban economic vitality, and principal component analysis reduces some factors and reduces the accuracy of the evaluation through dimensionality reduction. In this paper, the entropy method is used to evaluate the urban economic vitality of Beijing from 2013 to 2017, and the grey correlation method is used to study the specific impact of enterprise vitality and urban resident population on urban economic vitality.

2. Index Selection and Model Construction

2.1. Index Selection

Based on previous research results and collected data, this paper comprehensively evaluated the urban economic vitality of Beijing from 2013 to 2017 from the perspectives of local economic growth, the number of enterprises registered, foreign trade, and education level in the context of economic transformation by consulting materials and reading relevant literature.

Economic growth explains the urban economic vitality from the dynamic perspective and measures whether a city has the ability of sustainable development, which is one of the important indexes to evaluate the urban economic vitality. GDP is an important measurement index of urban economic capacity and an important basis for the future development of a city (Lu & Guo, 2007). This paper shows the level of economic growth through per capita regional GDP and regional GDP growth rate.

Enterprises are the micro-subject in the market economy, which plays an important role in promoting the market operation and innovation development. Both the quantity and quality of enterprises affect the development of the city in which they are located to some extent. The enterprise's science and technology, talent reserve and organizational structure all affect the urban vitality. The higher the enterprise vitality, the greater the role of promoting the urban economic vitality. In this paper, the number of enterprises and the size of the total profits of enterprises above the enterprise vitality.

Attractiveness to capital measures a city's ability to raise enough money to promote all aspects of its development. The amount of capital determines the size of urban output, and capital will flow to cities with better development and rich economic vitality. This paper shows the region's ability to import capital through its export volume and investment in fixed assets.

High-quality labor will increase the labor productivity of the city. To improve the quality of labor force by improving the education level of residents, high-quality labor force also has certain influence on the improvement of urban innovation ability and technological progress. This paper shows the quality of urban labor force by the number of resident population and the expenditure of urban education.

2.2. Model Construction

2.2.1. Entropy Method

Judging the dispersion degree of each index according to the size of entropy value is called entropy value method, in which the greater the entropy value is, the greater the index dispersion degree is, and the greater the weight of the index in the comprehensive evaluation factor is. If all the values of an indicator are equal, the indicator has no effect in the comprehensive evaluation. The principle and steps of entropy method are as follows: firstly, due to the difference in dimension of each index, in order to eliminate the influence of dimension, the data are

standardized:

$$\begin{cases} X_{ij} = \dfrac{x_{ij} - \min\left(x_{ij}\right)}{\max\left(x_{ij}\right) - \min\left(x_{ij}\right)} \text{Positive indicators} \\ X_{ij} = \dfrac{\max\left(x_{ij}\right) - x_{ij}}{\max\left(x_{ij}\right) - \min\left(x_{ij}\right)} \text{Negative indicators} \end{cases}$$

Then, the same degree of each factor index is quantified and the proportion of each factor is calculated

$$p_{ij} = \frac{X_{ij}}{\sum_1^s X_{ij}}$$

Secondly, calculate the entropy value of the ith index:

$$e_i = -k\sum_1^s p_{ij} \ln p_{ij}, k = \frac{1}{\ln s},$$

Then, Calculate the difference coefficient g_i of the ith index, and carry on the normalization processing, calculate the weight w_i

$$g_i = 1 - e_i$$

$$w_i = \frac{g_i}{\sum_1^s g_i}$$

Finally, the comprehensive score value s_j was calculated

$$S_j = \sum_{j=1}^n w_i X_{ij}$$

In the above types, n represents the year and s represents the index.

2.2.2. Grey Correlation Analysis

For the factors between two systems, the scale of the degree of correlation which varies with time or with different objects is called the correlation degree. In the process of system development, if the trend of change of the two factors is consistent, that is, the degree of synchronous change is high, then the degree of correlation between the two factors is high. On the contrary, the correlation between the two is low. Therefore, grey correlation analysis method, also known as "grey correlation degree", is a method to measure the degree of correlation among factors according to the degree of similarity or difference of development trend among factors. The main steps are as follows:

Step 1: Determine the comparison sequence and reference sequence between systems.

Step 2: standardize the data. Then, use the formula to calculate the correlation coefficient (δ_{0i})

$$\delta_{0i} = \frac{\Delta(\min) + \rho\Delta(\max)}{\Delta 0i(k) + \rho\Delta(\max)}$$

Step 3: since the correlation coefficient compares the correlation degree value

of the reference sequence and the comparison sequence at different moments, the number is more than one, so the correlation degree r is calculated on the basis of the correlation coefficient:

$$r = \frac{1}{N}\sum_{k=1}^{N}\delta(k)$$

where N is the year.

3. Results and Discussion

3.1. The Score of Beijing's Economic Vitality

This paper evaluates the urban economic vitality of Beijing from 2013 to 2017. The selected data are from Beijing statistical yearbook and the official website of the statistical database platform of China's economic and social development. Through the analysis of the selected eight indicators and four dimensions, the data was imported into the MATLAB software for calculation, and the weight of each indicator was obtained. The results can see Table 1.

As can be seen from the above table, the weight of enterprise registration is the smallest, which is 0.0818, and the weight of GDP growth rate is the largest, which is 0.1804. The weight is multiplied by the standardized value of the real data of various indicators in Beijing from 2013 to 2017 to obtain the urban economic vitality in the five years. The results can see Table 2.

From the data trend, from 2013 to 2017, the urban economic vitality of Beijing increased year by year and reached a maximum value of 0.7415 in 2017. From the perspective of data growth, the growth rate of urban economic vitality in 2013-2014 and 2016-2017 is relatively high, which is 39.32% and 48.95% respectively. In the middle three years, the growth of urban economic vitality was relatively stable. Among them, the growth rate was the highest in 2016-2017, which

Table 1. Index weight.

Index	Weight
GDP Per capita	0.1029
GDP growth rate	0.1804
Export value	0.1168
Investment in fixed assets	0.1682
Enterprise registration volume	0.0818
Total profits of enterprises above designated size	0.1212
Permanent population	0.0853
Education spending	0.1034

Table 2. The score of Beijing's economic vitality from 2013 to 2017.

Year	2013	2014	2015	2016	2017
Score	0.3245	0.4521	0.4568	0.4797	0.7415

may be related to the fact that Beijing implemented policies to promote the growth of urban economic vitality in 2016-2017. According to the observational data, the total profit of enterprises above the scale doubled in 2017 compared with 2016 (the total profit in 2016 was 106.826 billion yuan and the total profit in 2017 was 202.367 billion yuan), which may have promoted the improvement of the urban economic vitality of Beijing.

As the capital of China, Beijing has always set an example for the development of the whole country. "Twelfth five-year" period, Beijing actively responds to sustainable development strategy, it has been constructed in the aspects of production factor allocation, urban livable environment construction and so on. And the future of Beijing fully implement the "promote experiments in overall service industry in Beijing open still wider to the outside world work plan" to achieve higher levels of opening reform, making contributions to promote service industry comprehensive opening wider to the outside.

3.2. Analysis of Influencing Factors

Enterprise vitality and population quantity are important indexes to measure urban economic vitality. In this paper, the two indicators of enterprise vitality and population quantity are analyzed separately to study the influence of the changing trend of enterprise vitality and population quantity on urban economic vitality, The specific reasons are as follows: first, The number of enterprises directly affects how many jobs can be created, how much to promote the flow of resources, and how much economic benefits can be generated. Second, the more the number of enterprises, the higher the profit of the enterprise, the better the development prospects of the enterprise, the more the number of personnel, the number of urban resident population increases. Third, the larger the population, the greater the impact on the level of urban GDP. Fourth, the higher the enterprise profit, the higher the income, the greater the impact on urban development. Fifth, enterprise and the population's contribution to the regional economy is not confined to enterprises, the production capacity of the residents and taxes, it's more of an indirect effect. Cities with high economic vitality have better medical technology and perfect public service system, the influence of the virtuous circle mechanism to promote the enterprise's profit increase, urban labor increase, the sustainable development of urban overall ability get promoted. Therefore, the quantitative influence of enterprise vitality and population on urban economic vitality is studied.

This paper uses the grey relational analysis model to analyze the number of registered enterprises, the total profits of enterprises above the scale, the number of resident population and the value of urban economic vitality. Among them, the reference series is the value of urban economic vitality of Beijing from 2013 to 2017 calculated by the entropy method, and the comparison number is listed as the number of enterprise registration, the total profit of enterprises above the scale and the number of resident population from 2013 to 2017. MATLAB soft-

ware was used to calculate the correlation between enterprise vitality and population number and urban economic vitality. The results can see Table 3.

According to the calculation, the correlation between the number of enterprises registered, the total profits of enterprises above the scale and the number of population about the urban economic vitality of Beijing is $r1 = 0.7085$, $r2 = 0.5833$, and $r3 = 0.767$. From the perspective of quantity, $r3$ is greater than $r1$ is greater than $r2$. resident population and urban economic vitality have the highest correlation degree, and total corporate profits have the lowest correlation degree. The closer the grey correlation degree is to 1, the stronger the correlation is. The grey correlation between the number of enterprises and the number of population is greater than 0.7, indicating a strong correlation. The correlation degree of total profits of enterprises above the scale is between 0.5 and 0.6, and the correlation is general. The number of enterprises registered and the total profits of enterprises above the scale are collectively referred to as enterprise vitality. On average, the correlation between enterprise vitality and urban economic vitality is 0.6459, showing a strong correlation. Thus, it can be concluded that enterprise vitality and population change trend have a high impact on urban economic vitality, and provinces or cities can improve their economic vitality from this aspect.

Overall, enterprise vitality and population trend are highly correlated with urban economic vitality, for the following reasons: first, various types of enterprises in cities provide a variety of jobs, recruit various types of personnel, and form a new attraction force of personnel to promote population flow. Second, higher profits of urban enterprises indicate a better economic environment in the city, which promotes the development of enterprises and attracts more talents to start businesses and find jobs. Third, the increase in the number of permanent urban population leads to certain advantages in economic vitality and competitiveness compared with cities with a small population. Fourth, the improvement of labor force level is divided into quality improvement and quantity increase. The increase in population raises the level of labor force, and thus labor productivity. The high correlation degree also confirms the above analysis results of the qualitative impact of enterprise vitality and resident population on urban economic vitality.

4. Research Conclusion and Countermeasure Suggestion

4.1. Research Conclusion

Comprehensive evaluation model is based on the entropy value method and gray

Table 3. The correlation degree between enterprise vitality, resident population and urban economic vitality.

Index	Number of registered enterprises	Total profit of enterprises above the scale	Permanent population
Correlation	0.7085	0.5833	0.7670

correlation analysis model by using MATLAB software for 2013-2017, measuring and evaluating on the economic vitality of Beijing city, and analyzing the urban enterprise registration number, enterprises above designated size, total profit and the urban resident population change on the influence of urban economic energy value. The following conclusions are drawn: one is the city's GDP level, quality of labor force, capital inflow capacity, enterprise vitality is an important index of evaluating urban economic vitality, the government can start from these indicators to improve the economic vitality of the city. Beijing occupies certain advantages in these aspects, the expenditure of higher education occupies the forefront of the country, and the number of enterprises is large and growing year by year. Second, the urban economic vitality of Beijing has been increasing year by year, and there has been a substantial increase from 2016 to 2017, which may be caused by the increase of the total profits of enterprises above the scale. Third, enterprise vitality and resident population are strongly correlated with urban economic vitality. Among them, urban resident population correlation degree is superior to the enterprise registration, number correlation degree is better than that of total corporate profits.

4.2. Countermeasure Suggestion

According to the above evaluation results and influencing factors of Beijing's urban economic vitality, the following suggestions are put forward for the overall development of all provinces and cities in China: First, introduce policies to attract talent. As the national capital, Beijing attracts more talents. Other second- and third-tier cities should give full play to their advantages in geographical location and cultural environment, formulate reasonable policies to attract talents, implement a series of measures to attract young talents, and take the introduction of young talents as an important indicator of urban vitality (Liu, 2019); second, strengthen the vitality of enterprises, promote the development of private enterprises, let enterprises become the main body of the market. Enterprise vitality includes the number of enterprises registered, corporate profits, corporate registered capital, etc. The improvement of enterprise vitality plays an important role in promoting the growth of urban economic vitality. The government should encourage entrepreneurship, support employment, formulate policies to promote the development of small and medium-sized enterprises

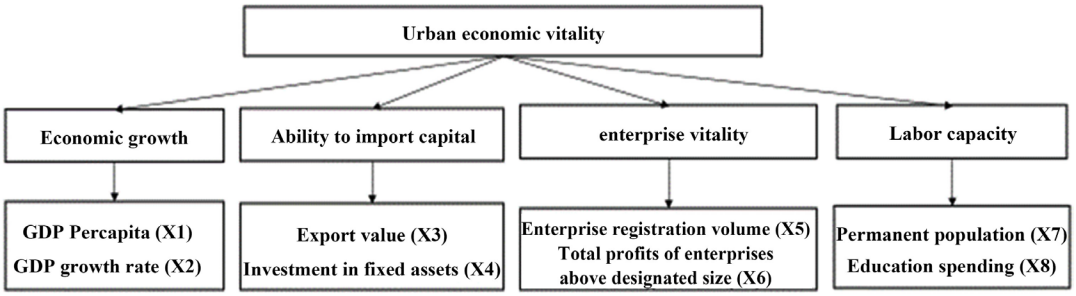

Figure 1. Evaluation index system of urban economic vitality.

and promote the development of enterprises. Each region should make full use of local resources, give play to characteristic industries, optimize regional industrial structure and promote sustainable and high-quality urban development. Third, first-tier cities can drive the development of second- and third-tier cities around them, to promote the coordinated and sustainable development of the region, and improve the economic vitality of cities in the region. For example, the development of central cities in the beijing-tianjin-hebei region and the Yangtze river delta region can promote the economic vitality of other cities in the region. See Figure 1.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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