



## ARTICLE

# Analysis and Forecast of Urban Economic Vitality in Northeast China

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### ABSTRACT

Taking into account the passage of time, the original economic vitality index will vary with changes in social development, we use the BP neural network nearly a decade as the original GDP data for the next 30 years the GDP forecast. BP neural network in 1985, proposed by Rumelhart, the algorithm solves the system of learning problems multilayer neural network connection weights hidden layer<sup>[1]</sup>. It consists of an input layer, a hidden layer, and an output layer. The principle is to continuously adjust the network weights and thresholds by transmitting errors backward and then correcting the errors to achieve the desired input-output mapping.

## 1. Analysis of Regional Economic Vitality in Northeast China

This paper mainly uses the analytic hierarchy process (AHP) to determine the weight of each indicator. The process is as follows:

### 1.1 Establishing a Hierarchical Structure of the Factors Affecting Regional Economic Vitality

According to different attributes, the related factors are decomposed into several layers from top to bottom<sup>[2]</sup>. The next layer of factors affects the upper layer of factors and the upper layer of factors dominates the next layer of factors. The target layer is the uppermost factor, and there is

only the analysis of regional economic vitality is the only factor. The middle layer is usually the indicator layer or the criterion layer, including 7 first-level indicators, and the lowest layer is the object layer or the program layer, including 17 second-level guarantees.<sup>[3]</sup> The specific hierarchical structure is shown in the following figure:

### 1.2 Construct a Judgment Matrix and Assign a Value

From the hierarchical structure obtained from the above table, we construct a judgment matrix.<sup>[3]</sup> The specific method of constructing the judgment matrix is as follows: The element of the criterion layer is taken as the first element of the judgment matrix, and the elements belonging

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to it are arranged in the first row and the first column, respectively. The judgment matrix refers to the opinions of multiple related professional teachers and students.<sup>[4]</sup>

The level indicators and secondary indicators integrated with the results shown in Table 1:

**Table 1.** HP results

Primary indicator	Consistency ratio	Weight to the overall goal	Lower level index	The weight of the lower layer to the upper layer	The weight of the lower layer to the overall goal
Economic vigor	0.0081	0.3095	Macroeconomic vitality	0.1567	0.0485
			External economic vitality	0.0882	0.273
			Enterprise economic vitality	0.2717	0.0841
			Per capita economic vitality	0.4830	0.1495
High-tech industrial environment	0.0000	0.3095	Vitality of high-tech industry	0.5000	0.1547
			Industrial agglomeration ability	0.5000	0.1574
Innovation environment	0.0015	0.1885	Innovation support capacity	0.0817	0.0154
			Innovation investment	0.6817	0.1285
			Innovative output capacity	0.2366	0.0446
Policy environment	0.0000	0.0659	Science and technology industry policy	0.8741	0.0576
			Tax policy	0.1244	0.0082
Financial environment	0.0000	0.0296	Degree of activity of property right transaction	0.3338	0.0233
			The degree of perfection of the financial service system	0.6662	0.0465
Humanistic environment	0.0000	0.0274	Interest incentive motive force	0.7976	0.0236
			Risk bearing ability	0.1993	0.0039

Above table shows that the consistency of the matrix is determined ratio is less than 0.10, to meet the requirements of the AHP index system.

According to the analysis of the first-level indicators, the high-tech industry environment and economic environment score the highest<sup>[5]</sup>; Analysis of secondary indicators shows that under the two indicators of high-tech industry and economic environment are: Vibrant high-tech industry and industrial clustering ability score (0.1574) up.

The top five indicators of a greater impact on the eco-

nomical vitality of the Northeast region are: policy environment, financial environment, innovation and the environment, economic environment and high-tech industrial environment, and that under the two indicators are the top eight secondary indicators, therefore, we will mainly discuss the analysis of level indicators.

### 1.3 High-Tech Industry Environment

High-tech industry is a source of power to stimulate economic vitality of the region, in the information era of knowledge economy, technology with its own unique value multiplier effect, to have a good ability to attract capital, the future trend of the market depend on the development of transformational technologies that will result in attractive technology for enhanced investment. Capital is the key factor that stimulates the vitality of the regional economy, and any capital is profit-oriented, and most high-tech industries have high returns<sup>[6]</sup>.

High-tech industrial environment by high-tech industry cluster capacity and high-tech industry to describe the vitality. We use the value-added of industrial enterprises above designated size, number and share of high-tech development zone of high-tech industry to consider, as well as the percentage change in the internal structure of its own high-tech industries have a more important impact on regional economic vitality in the regional economy<sup>[7]</sup>.

### 1.4 Economic Environment

Macroeconomic environment and regional economic vitality influence each other, touch each other. Research results indicate that the gross domestic product, the correlation coefficient between the amount of venture capital and new final consumption exceeds 0.5, relevant, so the economic environment has a great impact on regional economic vitality.

Economic environment mainly portrayed by per capita economic vitality and economic viability of the enterprise, foreign economic vitality and macro-economic vitality; macroeconomic ability to reflect the total economic potential for regional economic development of the product as well as residents, we mainly use the average growth rate of the gross production of the Northeast region for nearly 10 years; foreign economic vitality of the region reflects the ability to participate in international trade and investment to accept, mainly exports and foreign investment in Northeast China over the past decade to describe; companies can promote economic vitality and competitiveness of enterprises enterprise development; per capita economic vitality refers to the average affluence inhabitants of the region, we mainly use the average growth rate of nearly

10 years in Northeast China's GDP to represent.

### 1.5 Innovation Environment

Innovation is the lifeblood of the development of regional economy, regional economic vitality is usually accompanied by commercial and industrial innovations<sup>[8]</sup>.

Innovation input, innovation output capacity and ability to support innovation plays a decisive role in the environment of innovation, investment in innovation directly affects the size of the size of innovation capacity; productive capacity of innovation is the embodiment of technology transformation capabilities, is a concentrated expression of the economic vitality of regional innovation.

### 1.6 Policy Environment

Particularity of regional economic vitality of the policy decision, although the vitality of the regional economy is a market behavior in nature, but the dynamic excitation is inseparable from the support and good macro environment<sup>[9]</sup>. Policy support is mainly reflected in tax policy, policy support greatly affect investors' expectations for earnings, if not a good policy environment, investors will not invest capital in high technology venture capital projects, will affect the region Regional economic vitality<sup>[10]</sup>.

### 1.7 Human Environment

People of the region to the value orientation and the ability to accept new things with the development of regional economic vitality of certain influence within the region it is easy to accept new things, freedom of spirit. Higher operating efficiency will effectively promote the development of regional economic dynamism.

## 2. City Economic Vitality Forecast

Step 1: Initialization. Environmental degradation due to the different dimensions of cost data, normalizes here.

Step 2: Entering the loop, calculates the input hidden layer and output layer, the output value.

$$s_j^k = \sum_{i=1}^n a_i^k w_{ij} - \theta_j, \quad b_j^k = \frac{1}{1 + e^{-s_j^k}}, \quad j = 1, 2, \dots, p$$

$$l_j^k = \sum_{i=1}^p b_j^k v_i, \quad c_l^k = \frac{1}{1 + e^{-l_j^k}}, \quad t = 1, 2, \dots, q$$

Step 3: Reverse transfer error. Adjust each of the connection layer and the threshold value in accordance with the gradient descent method<sup>[11]</sup>.

$$E_k = \sum_{t=1}^q \frac{(y_t^k - c_t^k)^2}{2}$$

Step 4: Corrected weights and thresholds. Use the error of each node of the output layer and the hidden layer to modify the connection weight and threshold of each layer.

$$\begin{aligned} v_j(N+1) &= v_j(N) + \alpha d_t^k b_j^k \\ \gamma_t(N+1) &= \gamma_t(N) - \alpha d_t^k \\ w_j(N+1) &= w_j(N) + \beta h_j^k a_i^k \\ \theta_j(N+1) &= \theta_j(N) - \beta h_j^k \end{aligned}$$

However, the weights can BP algorithm converge to a certain value, but does not guarantee that the global minimum of the error plane, because the gradient descent method may produce a local minimum. For this problem, we use genetic algorithm optimization BP neural network weights and thresholds<sup>[12]</sup>. The specific process is as follows:

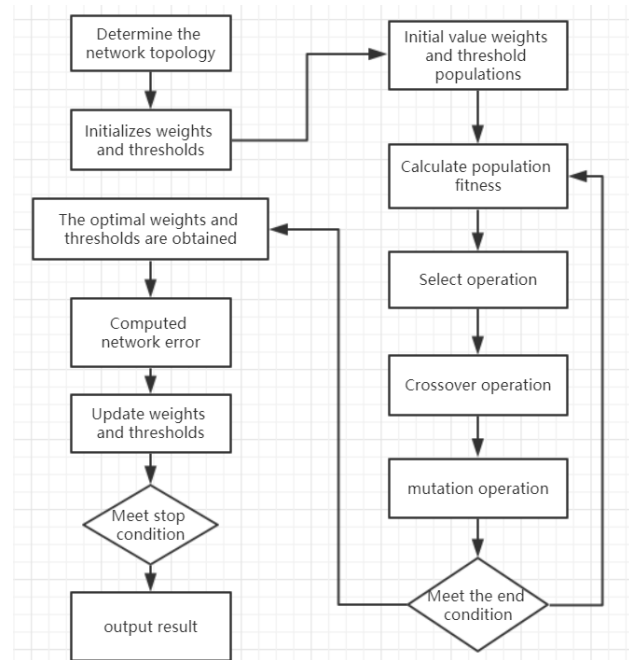


Figure 1. Prediction Model Flowchart

Based on genetic algorithm, BP neural network is used for prediction. The sample size is 50, the cross probability is 0.1, and the maximum evolution algebra is 100. According to the characteristics of the S-shaped function, which is slightly and non-linear, the S-shaped function is selected as the activation function, and Trainlm as a training function<sup>[13]</sup>. From the China Statistical Yearbook, we have found the GDP of the past 20 years, using it as the raw

data, input the BP neural network for training and testing. The simulation results are shown in the figure below.

**Table 2.** GDP of Heilongjiang Province in the past ten years

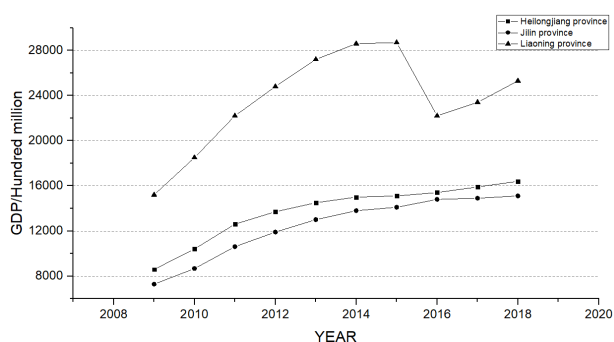
Year	2008	2009	2010	2011	2012	2013	2014	2016	2017	2018
Total GDP	0.85	1.04	1.26	1.37	1.45	1.50	1.51	1.54	1.59	1.64

**Table 3.** GDP of Jilin Province in the past ten years

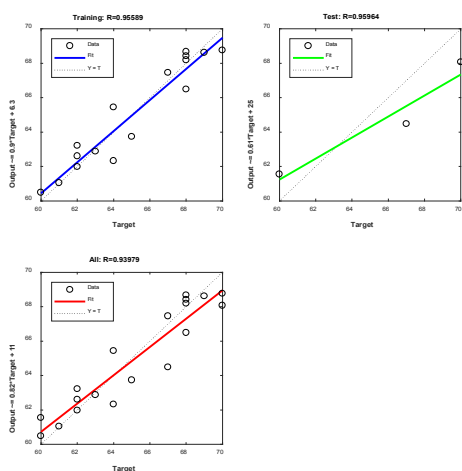
Year	2008	2009	2010	2011	2012	2013	2014	2016	2017	2018
Total GDP	0.73	0.86	1.06	1.19	1.30	1.38	1.41	1.48	1.49	1.51

**Table 4.** GDP of Liaoning Province in the past ten years

Year	2008	2009	2010	2011	2012	2013	2014	2016	2017	2018
Total GDP	1.52	1.85	2.22	2.48	2.72	2.86	2.87	2.22	2.34	2.53



**Figure 2.** Trend map of the total GDP of the three provinces in Northeast China



**Figure 3.** GDP error graph

From Chart 3-10 to see that most of the data distribution in the vicinity of a straight line, can explain the accuracy of the forecasts, GDP varied linearly over time, predict that in 2050 the northeastern region GDP will reach 100 trillion by the international market and government impact of regulation which is obviously impossible. Therefore, we introduce a new prediction model<sup>[14]</sup>.

$$\begin{cases} \frac{df}{dt} = af(t) - bf(t)^2 \\ \int_{f_0}^f \frac{dr}{ar - br^2} = \int_{t_0}^t ds = t - t_0 \end{cases}$$

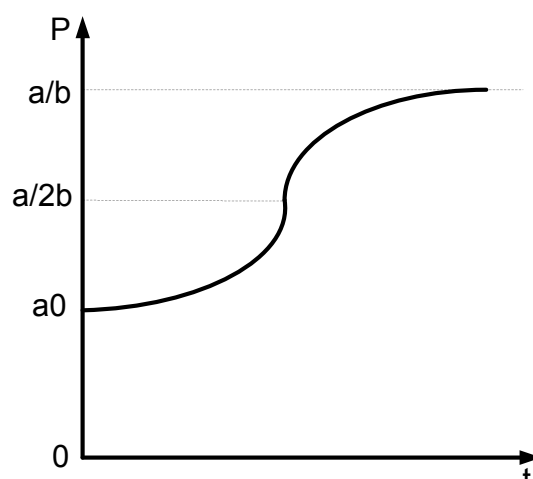
Where is the number of population, is the total initial GDP, and a and b are constants greater than 0. Solving the equation through the mathematical program, we can get:

$$f(t) = \frac{af_0}{bf_0 + (a - bf_0)e^{-at(t-t_0)}}$$

Obviously there

$$\lim_{t \rightarrow \infty} p(t) = \frac{a}{b}$$

Using MATLAB to make the image of formula (10), as shown in Chart 3-6, the real GDP growth should be an "S" curve. GDP is accelerating before a / 2b. When it reaches a / 2b, due to environmental factors, the growth rate will decrease. When the time is long enough, the GDP growth rate will tend to 0, and the total GDP will be in a dynamic and stable situation



**Figure 4.** Model of economic vitality growth

To sum up, the next three decades, economic development vitality Liaoning Province continued to hold first

place, followed by Jilin, Heilongjiang Province will continue for a long time at the stage of economic development vitality weaker. However, there are many uncontrollable factors in the vitality of regional economic development, such as policy tendencies and resource exploration, so it is impossible to make decisive predictions.

### **3. Recommendation Letter on Regional Economic Development**

#### **3.1 Research Investment**

Investment plays an important role in the promotion to enhance regional economic vitality, however, rely solely on the number of push to increase investment to enhance regional economic vitality of the Northeast is unrealistic, according to the diminishing marginal productivity of factors of production rules, with the region's economic vitality will As the amount of investment decreases, the increase in GDP will also decrease. Therefore, it is unrealistic to rely on the amount of investment to promote the improvement of regional economic vitality. The Northeast should invest limited funds in high-tech industrial projects to stimulate the economic vitality of the Northeast.

In terms of the financial system, the government and financial institutions are still the mainstay of China's investment. To enhance the vitality of regional economic development, the size of financial institutions in the Northeast should be expanded, and financial institutions should also increase their support for high-tech enterprises. Appropriately reduce the difficulty of establishing financial institutions and vigorously develop regional development banks and policy bank branches.<sup>[18]</sup> Decrease the statutory reserve ratio of commercial banks and increase the liquidity of funds, thereby enhancing regional economic vitality. The number and quality of scientific research personnel have a huge effect on the promotion of economic vitality. It is impossible to maintain the vitality of economic development by only the number of scientific research personnel. Northeast China must rely on local colleges and universities, focus on the quality of scientific research personnel, and cultivate a group of high-quality talents. Teams to play a demonstration effect and enhance the economic vitality of Northeast China.

#### **3.2 Aspects of Individual and Private Enterprises**

The self-employed can effectively enhance the economic development of the vitality of the Northeast, but the Northeast region of the self-employed and private enterprises started late, there is a wide gap with the developed areas in terms of scale, management, and fund-

ing. Therefore, the Northeast region should increase its support for self-employed and private enterprises, and encourage them to become bigger and stronger.<sup>[19]</sup> At the same time, the main businesses of self-employed and private enterprises in the Northeast are mainly low-end service industries, and the government should guide them to optimize their structures and upgrade their industries. In terms of private enterprises, Liaoning Province should pay attention to e-commerce, finance modern, intelligent manufacturing, new energy industry, textiles and clothing and other fields; Jilin Province should pay attention to the cultural and creative, healthy retirement, automobile spare parts, special resources and deep processing of agricultural areas; Heilongjiang Province We should pay attention to eco-tourism, modern logistics, processing of agricultural products, bio-pharmaceuticals and forest economy and other fields.

#### **3.3 Government and Industry Structure**

Government consumption play a stimulating role in enhancing economic vitality of the region. From 1954 to 2018, the proportion of government consumption in the Northeast increased from 4% to 58%. It is difficult to rely on government consumption alone to promote economic vitality. The government needs to carefully consider the efficiency and effectiveness of capital use. Excessive government intervention in the economy will lead to the weakening economic vitality, the government should adopt local administrative reform, in the form of legislation will be the responsibility of local government and intelligence explicitly create a favorable investment environment and attracting foreign investment, others are left to the market Make self-regulation<sup>[15]</sup>.

Industrial layout, the Northeast should, with its strong industrial base, relying on Northeast Asian cooperation platform, strengthen capital introduction, technology transfer and cooperative development, making the automotive, machinery manufacturing, agro-processing and petrochemical and other traditional pillar industries to electric vehicles, high-precision pointed machinery manufacturing, high-end food processing and specialty chemicals direction of upgrading the industrial structure, and gradually form their own complete industrial chain, the formation of industrial clusters<sup>[16]</sup>; support new materials, bio-pharmaceuticals, optoelectronics information emerging enterprises, the introduction of large environmental technology and environmental protection industry, the establishment of high value-added, low pollution, low energy consumption of a modern industrial clusters. In terms of logistics transportation, relying on the trunk lines such as the China-Munda Corridor, the Harbin-Dalian Line,

and the East Side Road, a modern integrated logistics system connecting Northeast Asia. In the service industry, we should vigorously develop modern service industries such as cultural creativity, service outsourcing, and financial insurance<sup>[17]</sup>.

### 3.4 Import and Export

Exports have positive effects to enhance the economic vitality of the Northeast. At present, the export of Northeast China is dominated by environmental and resource consumption, and its ability to pull regional economic vitality is limited. Therefore, the Northeast should be changed to raw materials and low-end products as the main export product model, to develop exports of automobile, petrochemical Seiko, bio-pharmaceuticals, agricultural products and other high-end products. At the same time, economic growth in developed countries better, are subject experienced capital, Northeast China should actively introduce foreign capital to further increase the introduction and use of overseas funds, so as to enhance regional economic vitality<sup>[18]</sup>.

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