

# Construction and Niche-fitness Evaluation of the Science and Technology Financial Ecosphere

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**ABSTRACT.** Firstly, based on the analysis of ecological theory, the paper defines the sci-tech financial ecosphere, which is the key way to achieve high quality economic development, can promote the integration and development of capital chain, innovation chain and industrial chain. And the model of sci-tech financial ecosphere that reveals its internal structure and operation pattern, is built on the basis of analyzing its elements. Then, the niche-fitness index system of sci-tech financial ecosphere is established from the ecological niche of the sci-tech finance ecological subject and the ecological environment. Niche-fitness evaluation model is used to evaluate the niche-fitness level of sci-tech financial ecosphere so as to measure the satisfaction degree of the actual resource conditions of sci-tech financial ecosphere to the high quality of economic development. Finally, the paper selects Beijing, Shanghai and Shenzhen as empirical research objects to evaluate the niche-fitness of sci-tech financial ecosphere during the period of 2010-2017, and puts forward some suggestions.

**KEYWORDS:** sci-tech financial ecosphere, high quality economic development, niche-fitness, evaluation

## 1. Introduction

The high-quality development of China's economy is inseparable from the promotion of sci-tech financial ecosphere. Many scholars at home and abroad have conducted research on sci-tech finance, among which Hsu et al. [1] and Nejad [2] analyzed the role of financial resources in promoting the development of scientific and technological innovation, from the one-way effect perspective of financial resource on sci-tech innovation; Xu Yulian et al. [3] studied the interaction and synergy between regional sci-tech innovation and sci-tech finance from the perspective of interaction. From the perspective of ecosphere or ecosystem, there is very little research on sci-tech finance: Hu Yixin [4] pointed out that the

construction of sci-tech financial ecosphere is a process of continuous evolution and improvement, which requires diversified sci-tech financial products, formats and government support; Zhang Haijun and Zhang Zuoming [5] pointed out the problems in the development mechanism of sci-tech finance in Hubei Province, and proposed that the development of sci-tech finance should be optimized around the innovation and entrepreneurship chain, and its construction should be the ultimate goal.

In October 2015, the Sci-Tech Finance Summit first proposed the new concept of “Sci-Tech Finance Ecosphere”. However, there is no in-depth research being done on the concept and development of it. It’s necessary to explore the connotation of the sci-tech financial ecosphere and study its development level. Based on the theory of ecology, this paper attempts to construct a sci-tech financial ecosphere. Based on the established niche-fitness evaluation index system, the niche-fitness model is used to evaluate its development level. Finally, taking Beijing, Shanghai and Shenzhen as examples to carry out empirical research, and put forward suggestions.

## **2. The Connotation and Construction of sci-tech financial ecosphere**

### ***2.1 The Connotation and Significance of sci-tech financial ecosphere***

Combining the ecological theory and the background of sci-tech financial ecosphere, this paper believes that the sci-tech financial ecosphere is based on the ecological environment of economy, law, credit and talents in a certain space area. By building a multi-type sci-tech financial service platform with various functions, effectively integrating the information resources of financial entities such as commercial banks, angel investments, venture capital and technology capital markets, innovative entities such as technology enterprises, universities and scientific research institutions, sci-tech financial intermediaries, and the government, developing an effective mechanisms for open investment, smoothing the communication channels between sci-tech innovation and financial capital, transformation channels for scientific research achievements and integration channels for industrial chain resources, promoting the integration and development of capital chain, innovation chain and industrial chain, forming a virtuous circle in which the value of financial capital drives the realization of sci-tech achievements, and the value of sci-tech achievements drives the appreciation of financial capital, and forming an integrated ecological chain.

The sci-tech financial ecosphere can not only promote the deep integration of sci-tech and finance, but also its construction is of great significance to the high-quality development of the economy. On the one hand, optimize the modern financial service system, and improve the level of the financial services real economy; on the other hand, highlight the central role of technological innovation to lead development, and improve the total factor productivity driven by innovation.

## 2.2 *The construction of sci-tech financial ecosphere*

The sci-tech financial ecosphere is composed of various functional sci-tech financial ecological subject and ecological environment, similar to the “biological elements” and “non-biological environmental elements” in the natural ecosystem.

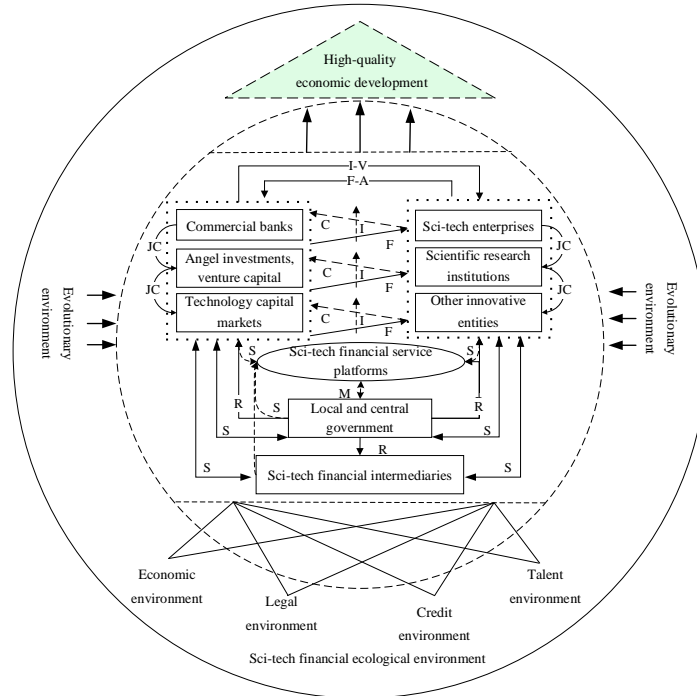
### (1) "Biological elements" – Sci-tech financial ecological subject

The ecological subject mainly includes sci-tech finance entities, sci-tech innovation entities, sci-tech financial intermediaries, sci-tech financial service platforms, and local and central government and other regulatory agencies. The sci-tech finance entities are the supplier of sci-tech financial service, consisting of commercial banks, angel investment institutions, venture capital institutions, technology capital market, etc. The sci-tech innovation entities are the demander of technology financial services, mainly including technology enterprises, scientific research institutions, universities and other innovative groups. The intermediary service agencies mainly include third-party service organizations such as asset assessment and credit evaluation. The sci-tech financial service platform provides all-round sci-tech financial services for sci-tech enterprises by integrating all kinds of resources, which is a key node for achieving information docking. The local and central government are the macro-controllers of the ecosphere.

### (2) "Non-biological elements" – Sci-tech financial ecological environment

The sci-tech financial environment includes the ecological basic environment and the ecological evolutionary environment. For the ecological basic environment, it includes external economic, legal, credit and talent environment. At the same time, during the development of ecosphere, the sci-tech financial development policies promulgated by the corresponding regulatory departments guide the evolution of the ecosphere in the development direction, and a series of financial innovations emerge within the financial system, including product, concept and models innovation, etc., greatly improve the utilization rate of sci-tech financial resources and promote the evolution of the ecosphere. Therefore, this paper believes that sci-tech financial policies and financial innovations have a "catalyst" effect on the development of ecosphere, and are the ecological evolutionary environment.

Based on the above analysis, the sci-tech financial ecosphere model is constructed (Fig 1). The sci-tech financial ecosphere has a hierarchy, in which the inner circle represents the core ecological chain of sci-tech finance and its ecological subject, and the outer circle represents the sci-tech financial ecological environment. The symbol “F-A” in Fig1 represents the value added of technology financial capital, “I-V” represents the realization of the value of sci-tech achievements, “F” represents the capital chain, “C” represents the innovation chain, “I” represents the industrial chain, and “JC” represents the competition relationship. “S” stands for partnership and “R” stands for government regulation.



*Figure. 1 Model of sci-tech financial ecosystem*

### 3. The niche-fitness evaluation of sci-tech financial ecosystem

The development of the sci-tech financial ecosystem will directly affect the high-quality economic development. Based on the niche-fitness theory, this paper evaluates the development level of the sci-tech financial ecosystem. The niche-fitness is a concept further proposed by Li Zizhen [6]. By measuring the degree of mutual adaptability between ecological factors (eco-factors), it reflects the closeness between the actual resource conditions and the optimal resource conditions, that is, the degree to which the actual resource conditions satisfies the specific demand.

#### 3.1 The niche-fitness index system of sci-tech financial ecosystem

This paper draws on Zhang Mingxi's [7] measurement of sci-tech financial ecosystem and research results of other scholars, and establishes 22 subdivided eco-factor indicators and builds the niche-fitness index system of the ecosystem from the dimensions of ecological subject and ecological environment, as shown in Table 1, reflects the characteristics of the development of the ecosystem.

(1) This paper measures the niche of ecological subject from the perspective of the integration degree of the capital chain and the innovation chain, and the integration degree of the innovation chain and the industrial chain.

1) The integration degree of the capital chain and the innovation chain

This paper evaluates the integration degree of the capital chain and the innovation chain from the perspective of capital investment and investment output level. For the capital investment, it is measured from seven aspects: angel investment support, venture capital support, technology loan strength, capital market support, technology insurance strength, financial technology allocation, and internal R&D support. For the level of investment output, use the level of financial development to measure, specific include the proportion of financial institutions' total deposits in GDP, financial institutions' total loans to GDP, and financial added value to GDP.

2) The integration degree between the innovation chain and the industry chain

This paper evaluates the integration degree between innovation chain and industry chain from the perspective of innovation output level and industrialization level. For the level of innovation output, the indicators include the amount of technology market contract, the number of invention patent applications received, the number of invention patents granted, and the number of scientific papers published. For the level of industrialization, the indicators include the sales revenue of new products in high-tech industries and the total output value of high-tech industries.

(2) This paper selects the ecological basic environment level and the ecological evolutionary environment level to measure the niche of sci-tech financial ecological environment.

1) Ecological basic environmental level

This paper measures the level of ecological basic environment from the level of economic, legal, credit and talent environment. The indicators include per capita GDP, settlement rate of the index economic case, non-performing loan ratio, and the number of sci-tech financial talents is selected.

2) Ecological evolutionary environment level

This paper measures the level of ecological evolutionary environment from the catalysis of sci-tech financial policies and the catalytic intensity of financial innovation, and selects the number of financial policies and the amount of credit products.

*Table 1 Niche-fitness index system of sci-tech financial ecosphere*

Indicator dimension	Indicator classification	Ecological factor
Niche of sci-tech financial ecological subject	The integration degree of the capital chain and innovation chain	X <sub>1</sub> Angel investment support
		X <sub>2</sub> Venture capital support
		X <sub>3</sub> Technology loan strength
		X <sub>4</sub> Capital market support
		X <sub>5</sub> Technology Insurance
		X <sub>6</sub> Financial technology funding
		X <sub>7</sub> Internal R & D support
		X <sub>8</sub> Financial institutions total deposits /GDP
		X <sub>9</sub> Financial institutions total loans /GDP
		X <sub>10</sub> Financial value added /GDP
	The integration degree between the innovation chain and industry chain	X <sub>11</sub> New product sales revenue
		X <sub>12</sub> High-tech industry total output value
		X <sub>13</sub> Technology market contract value
		X <sub>14</sub> Invention patent application acceptance
		X <sub>15</sub> Invention patent grant amount
		X <sub>16</sub> Scientific paper publication volume
Niche of sci-tech financial ecological environment	basic environment	X <sub>17</sub> Economic environment level
		X <sub>18</sub> Legal environment level
		X <sub>19</sub> Credit environment level
		X <sub>20</sub> Talent environment level
	evolutionary environment	X <sub>21</sub> Sci-tech financial policy catalytic strength
		X <sub>22</sub> Financial innovation catalytic strength

### 3.2 The niche-fitness evaluation model of sci-tech financial ecosphere

Based on niche-fitness evaluation index system, this paper draws on the measurement model proposed by Guo Yanqing [8] to establish the niche-fitness evaluation model for ecosphere.

Let  $X = \{x_1, x_2, \dots, x_n\}$  be the quantitative indicators of the selected n eco-factors, then the observation value of the evaluation object for m years constitutes the m-dimensional eco-factor space  $E^m = [X_{ij}]_{m \times n}$ , where  $i = 1, 2, \dots, m, j = 1, 2, \dots, n$ .

(1) Determination of eco-factor weight

First, the raw data needs to be standardized:

Positive indicator:

$$x'_{ij} = \frac{x_{ij} - \min_i |x_{ij}|}{\max_i |x_{ij}| - \min_i |x_{ij}|} \quad (1)$$

Negative indicator:

$$x'_{ij} = \frac{\max_i |x_{ij}| - x_{ij}}{\max_i |x_{ij}| - \min_i |x_{ij}|} \quad (2)$$

After standardization, the information entropy of each eco-factor can be calculated:

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^m k_{ij} \ln k_{ij} \quad (3)$$

Among

$$k_{ij} = \frac{x'_{ij}}{\sum_{i=1}^m x'_{ij}} \quad (4)$$

After determining the entropy value, the weights of the eco-factors can be calculated:

$$w_j = \frac{1 - e_j}{n - \sum_{j=1}^n e_j} \quad (5)$$

## (2) Niche-fitness model

The niche-fitness of the sci-tech financial ecosphere is the closeness between the actual value and the optimal value of the eco-factor. The calculation formula is as follows:

$$F_i = \sum_{j=1}^n w_j \frac{\delta_{\min} + \alpha \delta_{\max}}{\delta_{ij} + \alpha \delta_{\max}} \quad (6)$$

$$= \sum_{j=1}^n w_j \frac{\min_i \{|x'_{ij} - x'_{aj}|\} + \alpha \max_i \{|x'_{ij} - x'_{aj}|\}}{|x'_{ij} - x'_{aj}| + \alpha \max_i \{|x'_{ij} - x'_{aj}|\}}$$

Among them,  $w_j$  represents the weight of the eco-factor,  $\delta_{ij} = |x'_{ij} - x'_{aj}|$  ( $i = 1, 2, \dots, m; j = 1, 2, \dots, n$ ) represents the absolute difference between  $x'_{ij}$  and  $x'_{aj}$ ,  $x'_{aj}$  indicates the best niche of the  $i$ th eco-factor,  $F_i$  indicates the niche-fitness of the  $i$ th year of the sci-tech financial ecosphere ( $F_i \in [0, 1]$ ).  $\alpha$  is the model parameter ( $0 \leq \alpha \leq 1$ ), generally estimated from  $F_i = 0.5$ , which is  $\alpha = (\bar{\delta} - 2\delta_{\min})/\delta_{\max}$ , among them  $\bar{\delta} = \sum_{i=1}^m \sum_{j=1}^n \delta_{ij}/mn$ .

The evolutionary momentum is defined as the deviation degree of the actual niche from its best niche. The larger the evolutionary momentum, the greater the degree of deviation. The calculation formula is as follows:

$$EM_i = \sqrt{\sum_{j=1}^n \delta_{ij} / n} \quad (i = 1, 2, \dots, m) \quad (7)$$

#### 4. Empirical Research

In order to further study the development of Shanghai's sci-tech financial ecosphere, this paper selects Beijing and Shenzhen as the empirical analysis objects and conducts comparative research.

##### 4.1 Data processing and source

This paper selects the indicator data of Beijing, Shanghai and Shenzhen during 2010-2017. The data comes from the *China Science and Technology Finance Ecological Annual Observation Report*, *China Angel Investment Research and Development Report*, *China Venture Capital Investment Development Report*, and the city's statistical yearbook, Peking University Legal Law Database, and Wind Financial Consulting Terminal. The individual data is missing and is supplemented by the proportional method. Since some indicators have no published statistical data, this paper refers to the measured indicator of reference [9]-[11], and does the following: the cumulative insurance coverage of sci-tech insurance is replaced by the insurance institution insurance depth [9], that is, the proportion of premium income to GDP. The economic cases settlement rate is replaced by the proportion of lawyers per million lawyers [10]; the number of sci-tech financial talents is replaced by the proportion of the number of people engaged in sci-tech activities [11].

##### 4.2 Evaluation result of niche-fitness

Based on the niche-fitness model, the niche-fitness (F) and evolutionary momentum (EM) of the ecosphere during 2010-2017 are calculated, as shown in Table 2 and Figure 2, as well as the niche-fitness of the sci-tech financial ecological subject (F1) and ecological environment (F2) of each region are calculated, as shown in Table 3 and Figure 3.

Table 2 Evaluation results of niche-fitness and evolutionary momentum

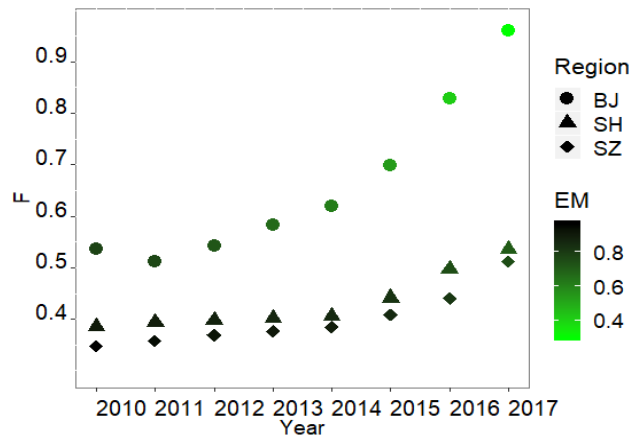
Year	Region	2010	2011	2012	2013	2014	2015	2016	2017
F	BJ	0.537	0.511	0.542	0.584	0.620	0.698	0.828	0.960
	SH	0.385	0.394	0.397	0.402	0.406	0.441	0.497	0.535
	SZ	0.347	0.358	0.369	0.377	0.385	0.409	0.440	0.512



EM	BJ	0.777	0.766	0.724	0.667	0.615	0.538	0.415	0.296
	SH	0.906	0.892	0.879	0.864	0.856	0.826	0.749	0.707
	SZ	0.965	0.943	0.921	0.911	0.892	0.856	0.812	0.748

*Table 3 Niche-fitness evaluation results of ecological subject and environment*

Year	Region	2010	2011	2012	2013	2014	2015	2016	2017
F1	BJ	0.502	0.475	0.492	0.509	0.575	0.687	0.799	0.931
	SH	0.379	0.377	0.385	0.389	0.401	0.437	0.480	0.505
	SZ	0.348	0.356	0.360	0.364	0.379	0.409	0.440	0.516
F2	BJ	0.549	0.548	0.608	0.748	0.648	0.668	0.795	0.889
	SH	0.405	0.449	0.438	0.444	0.424	0.455	0.553	0.636
	SZ	0.347	0.366	0.405	0.420	0.409	0.409	0.442	0.497



*Figure. 2 Niche-fitness and evolutionary momentum results of sci-tech financial ecosystem*

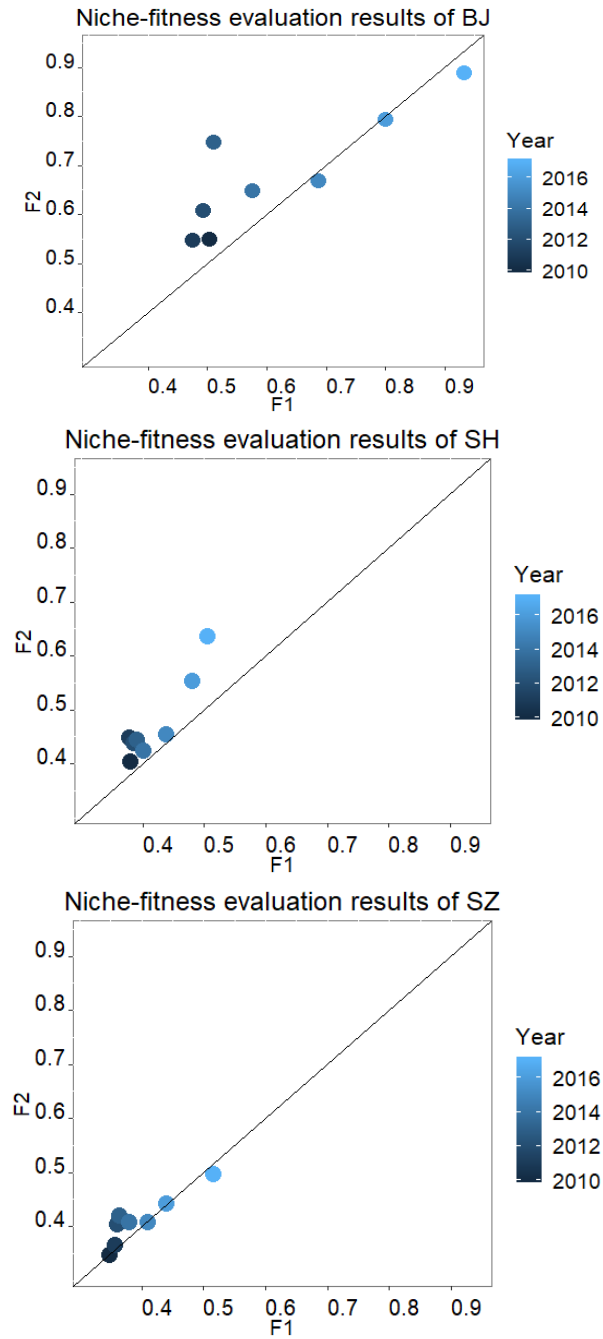


Figure. 3 Niche-fitness evaluation results of F1 and F2

(1) From the evaluation of niche-fitness and evolutionary momentum, it can be known that:

During the period of 2010-2017, the sci-tech financial ecosphere in Beijing, Shanghai and Shenzhen showed a good development trend. The niche-fitness increased year by year, and the evolutionary momentum decreased year by year. The niche-fitness of the Beijing has increased from 0.537 to 0.960 year by year, and the evolutionary momentum has been gradually reduced from 0.777 to 0.296, which is obviously better than that of Shanghai and Shenzhen. Comparing the niche-fitness and evolutionary momentum result in Shanghai and Shenzhen, Shanghai is slightly better than that of Shenzhen, but the overall niche-fitness of the two is still below 0.6, indicating that there is still there is a lot of room for evolution.

(2) From the evaluation results of ecological subject and environment, it can be known that:

During the period of 2010-2017, the niche-fitness of ecological subject and ecological environment in Beijing, Shanghai and Shenzhen showed an overall upward trend. The niche-fitness result of Beijing is significantly better than that of Shanghai and Shenzhen. The niche-fitness result of Shanghai is slightly better than that of Shenzhen. However, there are unstable factors in the development process. For example, the overall development coordination of the Beijing and Shenzhen ecosphere, but the niche-fitness of the ecological subject in the early stage of development is obviously lagging behind the development of ecological environment. The niche-fitness result of Shanghai showed a significant upward trend after 2015. However, the ecological subject and ecological environment have not shown a coordinated development trend, which may inhibit the further development of the ecosphere to a certain extent.

## 5. Conclusion and suggestions

This paper combines ecological theory to study the connotation, structure and development level of the sci-tech financial ecosphere. First, build a sci-tech financial ecosphere, unblock the channels of sci-tech innovation and financial capital, and form the integration of capital chain, innovation chain and industrial chain led by sci-tech innovation. Then establish the niche-fitness index system and evaluate the niche-fitness level by means of niche-fitness evaluation model to measure the satisfaction degree of real resource conditions to achieve high-quality economic development. Finally, Beijing, Shanghai and Shenzhen were selected for empirical research. The ecological niche-fitness of Beijing is significantly better than that of Shanghai and Shenzhen. The niche-fitness of Shanghai is slightly better than that of Shenzhen. For the further development of the Shanghai's sci-tech financial ecosphere, the governments need to recognize the equal importance of the ecological subject and the ecological environment, and take measures to promote the coordinated development of the two, in order to effectively promote the high-quality development of the economy.

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