Research on Evaluation Model of Regional Financial Science and Technology Development Based on Local Variable Weight

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Abstract. With the development of financial science and technology, how to accurately evaluate the development level of regional financial science and technology has become particularly important. This paper first establishes the evaluation index system of regional financial science and technology development, which is composed of six first-class indicators and fourteen second-class indicators, which comes from the identification of influencing factors of financial science and technology development. Then, based on the idea of local variable weight, a comprehensive evaluation method of regional financial science and technology based on local variable weight is designed, and the scientificity and feasibility of the method are verified by data. The local variable weight comprehensive evaluation method can realize the objective and flexible weight setting, and the future research can do more in-depth research on parameter optimization and vector pattern construction.

Keywords. Development of financial science and technology; partial variable weight synthesis method; index system

1. Introduction
Financial technology is technology-driven financial innovation, the aim is to use modern scientific and technological achievements to transform or innovate financial products, business models and business processes, so as to improve the quality and efficiency of financial development. In the context of a new round of scientific and technological revolution and industrial change, financial technology is booming, artificial intelligence, big data, cloud computing, Internet of things and other information technology and financial business in-depth integration, providing a continuous stream of innovative vitality for financial development. However, financial technology, which has developed in recent years, is not very mature in theory and practice, which has brought a series of problems for regional development. Therefore, there is an urgent need to do in-depth research on the development level of regional financial technology, in order to better serve the development of regional financial technology. Therefore, this paper will first analyze the construction principles of the index system, then design the evaluation index system of regional financial technology development according to the construction principles, and establish the corresponding evaluation model according to the operation
process of financial technology evaluation. And then evaluate the development of regional financial technology. In this paper, the local variable weight comprehensive evaluation method is introduced into the evaluation of regional financial technology development for the first time, which can avoid the evaluation error caused by the fixed weight value, so as to provide a more objective and accurate evaluation.

2. Financial risk evaluation index of Internet supply chain

2.1 Principles for the construction of index system

In order to evaluate the development level of financial science and technology in mutual regions more objectively and truly, the evaluation index system needs to follow the following rules:

(1) Principle of integrity and completeness

The evaluation index of regional financial science and technology development needs a complete evaluation in the aspects of science and technology financial output, science and technology financial market, science and technology financial funds input and so on, so the index system is required to be overall and complete.

(2) The principle of typicality and practicality

The development of regional financial science and technology is determined by all kinds of factors, and if we want to find the important factors from a variety of factors, we need to pay attention to the typicality of influence. At the same time, various factors need to be easy to obtain and have practical value.

(3) Quantitative and non-quantitative principles

The evaluation index of regional financial science and technology development needs to obtain quantifiable indicators as far as possible and be objective and reasonable as far as possible, but some indicators can not be quantified, such as the importance of science, technology and finance, so in the process of formulation, therefore, the combination of quantitative and non-quantitative methods should be adopted.

2.2 Index description and system composition

The evaluation indicators and system composition of regional financial science and technology development are shown in Figure 1.

![Figure 1. Evaluation index and composition of regional financial science and technology development](image-url)
Science and technology development level
(1) The index of science and technology business incubation rate (U1)
The index of science and technology business incubation rate focuses on the resources of entrepreneurial mentors and the investment of mass entrepreneurship and innovation platform.
(2) The index of science and technology financial output rate (U2). Science and technology financial output includes technology market transaction index, patent output index and high-tech enterprise output index.
(3) Indicators of science and technology financial resources (U3) Science and technology financial resources, key science and technology human resources and science and technology research and development resources.
(4) The indicators of the science and technology capital market (U4).
The key trading activity of the science and technology capital market, the support strength of the gem and the support strength of the new third board.
(5) The index of science and technology financial expenditure (U5). Science and technology financial expenditure focuses on the intensity of investment and the degree of marketization of Redd.
(6) The index of science and technology loan (U6)
Science and technology loan focuses on private lending and bank credit.

3. Index weight determination

3.1 Construct comparison matrix C
The weight can be determined by pairwise comparison of indicators.
Specifically, you can resort to the expert scoring method. First of all, experts are invited to make the comparison matrix C by dividing it on the basis of the different importance of the comparison index.

$$C = \begin{pmatrix} c_{ij} \end{pmatrix}, \quad c_{ij} > 0, \quad c_{ji} = 1 / c_{ij}$$

(1)

Here Cij represents the ratio of index weight, and the value of Cij can be obtained through a pairwise comparison matrix composed of two factors of level 1 to 9. When the two factors are equally important, the value is 1; the other values are from 1 to 9 according to the degree of importance.
Both 1, 2, 3, 4, 5, 6, 7, 8, 9, take the opposite 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9
In this way, experts can get a pairwise comparison matrix after scoring the weight according to the pairwise comparison of factors.

3.2 Calculate weight value
Calculate the product Mi: of each row factor of the judgment matrix

$$M_i = \prod_{j=1}^{n} a_{ij}; \quad i = 1, 2, \ldots, n$$

(2)

Calculate Wi: $$W_i = M_i^{1/n}.$$
Calculate weight w: $$w = [w_1, \ w_2, \ldots, \ w_n]^T$$

3.3 Consistency verification
In order to make the judgment matrix obtained by experts have consistency, it needs to be verified by consistency.

4. Comprehensive evaluation of regional financial technology development level with partial weight change
To evaluate the development level of regional financial technology, it is necessary to follow the evaluation indicators. Based on the quantitative scores of the evaluation indicators, according to the weights of different indicators, the evaluation index values are collected into a comprehensive
evaluation value process. The key here is how to integrate. Finding an optimal method in the method requires starting from the state of the object being evaluated. That is to say, based on the state value of the obtained evaluation index, it is necessary to select a comprehensive evaluation function, and then obtain the comprehensive evaluation value of each evaluated object, and finally realize the objective evaluation of the evaluated object [1].

The current research on regional financial technology development evaluation uses more fixed-weight evaluation methods. Fixed weights cannot objectively reflect the actual situation of the evaluated objects. The evaluation weights are generally obtained through expert scores. This weight does not change with the status value of the evaluation index, which will affect the authenticity of the actual evaluation. Therefore, the authenticity and accuracy of the results cannot be guaranteed. In this regard, this article introduces a comprehensive evaluation method based on the idea of variable weight to effectively solve this unreasonable problem. By designing the weight that changes with the state value of the indicator, the actual situation of the indicator can be more realistically described. The weight is changed. The real, therefore, is objective, scientific, and ubiquitous; while the fixed weight is artificial, relative, and has its particularity [2]. The idea of weight change was first given by Professor Hongxing Li in the literature [3,4].It can be obtained from the theory of Professor Li , Constant weight vector $w=(w_1, w_2, ...w_i... , w_m)$ and state variable weight vector $S(X)=(S_1(X), S_2(X),...S_i(X)...,S_m(X))$’s Hadamard product variable weight vector $W(X)$, the formula is:

$$w(X) = (w_1(X)...w_i(X)...w_m(X)) = (w_1S_1(X)...w_iS_i(X)...w_mS_m(X))/\sum w_iS_i(X)$$

As far as the comprehensive evaluation of regional financial technology development level is concerned, the aggregation method should not only pay attention to the universality of regional financial technology development, but also take into account the particularity of regional financial technology development. Therefore, the comprehensive evaluation model of local variable weight can be obtained by the following formula [5].

Definition 1 Set mapping $S: [0,1]^m\rightarrow(0, +\infty)^m$, then vector $S(X)=(S_1(X), S_2(X),...S_i(X)...,S_m(X))$ is a local state variable weight vector with m dimensions, all the $i \in \{1,2,\cdots,m\}$,If there is always $\alpha_i, \beta_i \in (0,1)$ and $\alpha_i \leq \beta_i$, meet the following rules:

1. If $i \in \{1,2,\cdots,m\}$,solve in equation (3) $w_i(X)$ in $[0, \alpha_i]$ and it decreases with $x_i$, and at the same time increases monotonically with $x_i$ on $[\beta_i,1]$.

2. When $0 \leq x_j \leq x_k \leq \alpha_j \land \beta_j \leq x_j \leq x_k \leq 1$, $S_j(X) \geq S_k(X)$;then $\beta_j \leq x_j \leq x_k \leq 1$, $S_j(X) \leq S_k(X)$.

$y=w(x)x$ as a comprehensive evaluation function.

According to the validity and rationality of the comprehensive evaluation of the regional financial technology development level, the variable weight formula designed according to Definition 1 based on the local state variable weight idea is:

$$S_i(X) = \begin{cases} \frac{1}{p-u} x_i + \left[ 1 - \frac{q-1}{p-u} \right] \cdot u & x_i \in [0, \alpha_i] \\ \frac{q-1}{1-t} x_i + \left[ 1 - \frac{1-q}{1-t} \right] & x_i \in [\alpha_i, \beta_i] \\ \frac{1-q}{1-t} x_i + \left[ 1 - \frac{q-1}{p-u} \right] \cdot u & x_i \in [\beta_i,1] \end{cases}$$

(i=1,2,\cdots,6),The values of the parameters $u$, $p$, $t$, and $q$ are 0 to 1. Here, $u$ is the rejection degree, $p$ is the pass degree; $t$ is the reward degree; $q$ is the adjustment degree. When $x_i$ is between 0 and $u$, the degree of punishment is the largest; when $x_i$ is between $u$ and $p$, the degree of punishment decreases as $x_i$ increases; when $x_i$ is between $t$ and 1, as $x_i$ changes The degree of large reward will also become larger; as the adjustment degree $q$ becomes smaller, the degree of punishment will become larger, and the degree of reward will also become larger. The greater the degree of adjustment $q$ becomes, the smaller the degree of punishment and incentive will be [6].

5. Instance verification
Based on the actual situation of the regional financial technology development level, set \( u = 0.4; p = 0.7; t = 0.9; q = 0.2 \), we can get:

\[
S_i(x) = \begin{cases} 
1 & x_i \in [0, 0.4] \\
2.6 - 4x_i & x_i \in [0.4, 0.7] \\
0.2 & x_i \in [0.7, 0.9] \\
8x_i - 7 & x_i \in [0.9, 1]
\end{cases}
\]  
(5)

Secondly, the effectiveness of the evaluation method is verified through specific data and calculation examples. The specific data and evaluation results of the pre-processed financial technology development in A and B are shown in Table 1.

| Index | Index value | constant weight w | Local variable weight w(x) | Variable weight w(x) | Constant weight comprehensive value | Variable weight comprehensive value |
|-------|-------------|-------------------|----------------------------|----------------------|-------------------------------------|-------------------------------------|
|       | A           | B                 |                            | A                    | B                                   | A                                   | B                                   |
| U11   | 0.85        | 0.71              | 0.05                       | 0.2                  | 0.2                                 | 0.036232                            | 0.02659                             |
| U12   | 0.5         | 0.9               | 0.05                       | 0.6                  | 0.2                                 | 0.108696                            | 0.02659                             |
| U21   | 0.85        | 0.71              | 0.04                       | 0.2                  | 0.2                                 | 0.028986                            | 0.02127                             |
| U22   | 0.85        | 0.71              | 0.03                       | 0.2                  | 0.2                                 | 0.021739                            | 0.01595                             |
| U31   | 0.8         | 0.95              | 0.10                       | 0.6                  | 1.0                                 | 0.072464                            | 0.26595                             |
| U32   | 0.9         | 0.9               | 0.10                       | 0.2                  | 0.2                                 | 0.072464                            | 0.05319                             |
| U41   | 0.71        | 0.85              | 0.09                       | 0.2                  | 0.2                                 | 0.065217                            | 0.04787                             |
| U42   | 0.5         | 0.85              | 0.09                       | 0.6                  | 0.2                                 | 0.195652                            | 0.04787                             |
| U43   | 0.8         | 0.95              | 0.12                       | 0.2                  | 1.0                                 | 0.086957                            | 0.31914                             |
| U51   | 0.9         | 0.9               | 0.05                       | 0.2                  | 0.2                                 | 0.108696                            | 0.02659                             |
| U52   | 0.85        | 0.71              | 0.05                       | 0.2                  | 0.2                                 | 0.036232                            | 0.02659                             |
| U61   | 0.85        | 0.71              | 0.10                       | 0.2                  | 0.2                                 | 0.072464                            | 0.05319                             |
| U62   | 0.9         | 0.9               | 0.10                       | 0.2                  | 0.2                                 | 0.072464                            | 0.05319                             |

From the comparison of the comprehensive value of constant weight and the comprehensive value of variable weight in Table 1, it can be seen that the indicators in area A generally score higher than those in area B. However, because the evaluation values of the indicators U12 and U42 in area A are much lower than those in area B, its comprehensive evaluation value is reduced from 0.7899 to 0.739, and the penalty is achieved through the change of weight; while the indicators U12 and U42 in area B U42 has a relatively high evaluation value, which causes its comprehensive evaluation value to rise from 0.845 to 0.8941, achieving the purpose of incentives. These two indicators are two indicators that the development of regional financial technology is very concerned.

Finally, compare the regional financial technology development evaluation index data in Table 1 in the form of trend graphs. The results of the comparison are shown in Figure 2 and Figure 3. The abscissa represents 1-14 evaluation indicators, the ordinate is the value, and the yellow represents the change curve of constant weight value, and blue represents the change curve of variable weight value.
Figure 2. The area A

Figure 3. The area B

It can be seen from Figure 2 and Figure 3 that for regions A and B, the index U31 and U43 with constant weights are greatly affected by the index value. When the U31 value is too small or too large, the weight is increased and decreased, resulting in obvious incentive or punishment effects; for indicators with low weight, such as the value of U23, it can also be affected by the value of the indicator, so it can also be rewarded and punished to a certain extent effect. The actual evaluation is precisely such a situation. The effectiveness and objectivity of regional financial technology development level evaluation can be realized through weight changes, and the problems caused by fixed weights can be corrected.

6. Conclusion

This paper introduces the comprehensive evaluation method of partial variable weight into the risk evaluation of regional financial technology development for the first time. First, a set of regional financial technology development evaluation system is designed according to the construction principle of evaluation indicators, and then based on the regional financial technology development evaluation, it is necessary to emphasize the universal development On the basis of emphasizing the particularity of regional development, a comprehensive evaluation method is constructed by introducing the idea of local variable weight, and finally the effectiveness and rationality of the method is verified through actual data. Since this article introduces the idea of local variable weight for the first time, there are still some areas that need further improvement and research, such as whether there are more objective methods for the selection of some key parameters.

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