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# The Research on Cooperative Ability of Technology and Finance in Western China based on ANP-FCE Model

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***Abstract***

*With the steady economic development in the western region of China, technology and finance has gradually become the inevitable choice of adjusting economic structure and maintaining sustainable development. From the premise of developmental characteristics of technology and finance in western area, this article constructed the index evaluation system of cooperative ability of technology and finance and conducted in-depth research on collaborative ability of technology and finance in the west region of China using ANP-FCE model, and put forward relevant suggestions for improvement to accelerate the economic development as well as enhance collaboration ability of technology and finance in western area .*

***Keywords:*** *Technology and finance, fuzzy comprehensive evaluation method (FCE), analytic network process (ANP), scientific innovation*

## 1. Introduction

After the financial crisis in 2008, the global financial system and economic growth face unprecedented challenges. According to the great influence of this financial crisis, the State Council of China put forward the collaborative development of technology and financial in policy documents Technology and finance is an important means to improve China's core competitiveness. And the report of the Eighteenth National Congress of the CPC put forward the following content: Implementing innovation-driven strategy, regarding technological innovation as the strategic support to improve the social productivity and comprehensive strength and putting it in the core position of national development.

At present, the western region of China is in an important period of leap development. The gradual implementations of West Development Program make technology and finance an inevitable choice to adjust economic structure and to achieve conservation-oriented economic pattern. In western area of China, such as in Chengdu, Sichuan Province, the government has already established "trapezoid financing model" and set up the small and medium-sized enterprise investment and financing service platform, the core of which is "powerful innovation", and put forward the construction of symbiotic technology and financial integration between small and medium-sized enterprises and financial institutions. Considering the characteristics of western region and factors influencing technology and finance, this paper establish the corresponding index evaluation system and value the cooperative ability of technology and finance in western China by using ANP-FCE model. This paper then put forward the improving suggestions for future development.

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## 2. Establishment of the Evaluation System

According to the comprehensive, comparable, scientific, practical and easy processing features of designing index, considering the challenges in the collaborative ability between technology and finance as well as technology innovation in western area, and the technology-oriented reality, this paper summaries index analysis results from four dimensions: policy factors, risk factors, technical factors and market factors, and subdivide second index. Then the paper establishes comprehensive index evaluation system of technology and finance's coordination capacity.

(1) Policy factor (B1). The collaborative development of science & technology innovation and finance is inseparable from the support and policy of government and related institutions. Relevant preferential policies and fiscal funds for science& technology innovation and finance will encourage the development of small and medium enterprises, promote the progress and innovation of China's science and technology and increase the loans from financial institutions to scientific projects. Therefore, we select financial allocation proportion (C1), the preferential tax policy (C2), the efficiency of the resources allocation in science& Technology (C3), the proportion of bank loans (C4) as second indexes to reflect the government impact in the collaborative ability in science& technology and finance.

(2) Risk factors (B2). In recent years, venture capital in China witnesses a boom in terms of scale, the source of funds, the project selection and cultivation. Risk investment has become an indispensable part in the development of science& technology innovation and finance. However, the risk factors are uncertain. Therefore, we select the total risk investment capital (C5), the number of venture capital institutions (C6) as second indexes.

(3) Technical factor (B3). The advanced technology and potential innovation are the key elements for national science and technology as well as the safeguard of a country's hard strength. In addition, the transformation of scientific and technological achievements is more important. Owning science and technology but not transforming into substantive results, the final aim of science cannot be realized. Therefore, we select transformation rate of science& technology achievements (C7), technology innovation potential (C8), industry aggregation (C9), advanced technology (C10) as second indexes.

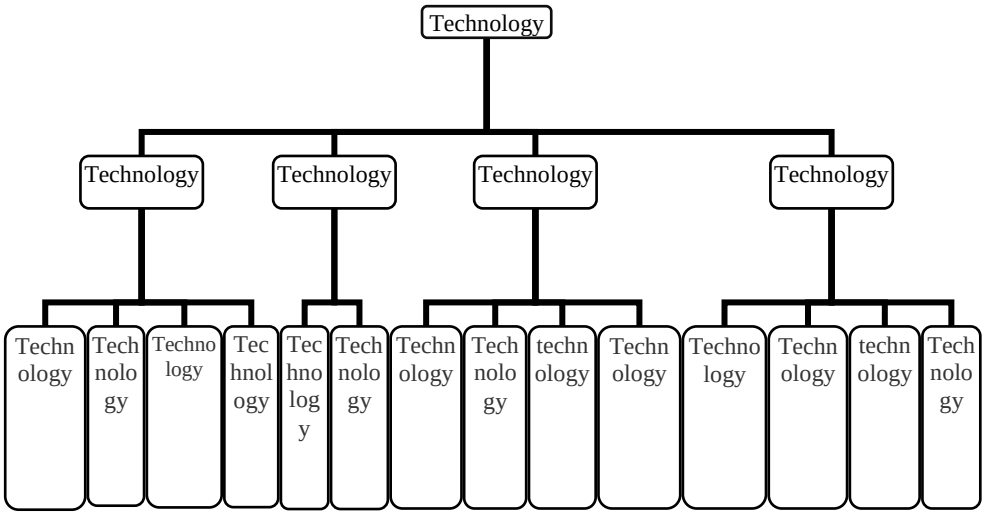


**Figure 1. The Index Evaluation System for Cooperative Ability of Technology and Finance in Western China**

(4) Market factor (B4). The existing science &technology and finance market consists of science& technology enterprises, science& technology banks and professional technical personnel etc. In technological market, the number of enterprises and capital scale reflects

 

scientific level in one area. The number of science& technology banks is closely related to the number of science& technology enterprises and their scale. At present, under China's people-oriented policy and talent strategy, the cultivation of high-level innovation talents and entrepreneurship management talents become the top priority. Therefore, we select the number of listed technology enterprises (C11), the capital scale of science &technology enterprises (C12), science and technology talent specialization (C13) and the number of science& technology banks (C14) as four second indexes.

After analyzing the above indexes, we put forward the index evaluation system for cooperative ability of technology and finance in western China. The system is shown in Figure 1.

## 3. Construction of ANP-FCE Evaluation Model

Western region in China mainly consists Sichuan Province, Xinjiang Uygur Autonomous Region, Shanxi Province, Ningxia Hui Autonomous Region, Yunnan Province, Guizhou province and other 10 provinces, with land area of 5450000 square kilometers accounting for 57% of the total national area. This paper took Sichuan Province and Xinjiang Uygur Autonomous Region as example, whose economic development occupy an important position in western regions. Combined with the index evaluation system for cooperative ability of technology and finance in western China, this paper uses ANP-FCE model to evaluate the coordination ability of technology and finance in western area.

### 3.1. Index Weights

At present, the distribution of evaluation indexes weight generally uses analytic hierarchy process (AHP). However, AHP pay more attention to the effect of first level indexes on the second level indexes, while ignoring the fact that the peer indexes also has mutual influence. Network analysis method (ANP) is an improvement for AHP, which considers the effects of peer index to make up for its shortcomings. Therefore, this paper adopted the network analysis method with the help of the Super Decisions (super decision software) to gain the weight of influence factors and to better make quantitative process on qualitative analysis. In order to ensure the rationality of influencing factor weights, we verify the consistency of evaluation index through $CR = CI / RI = \lambda_{max-n} / (n-1) RI < 0.1$, same as AHP method. If $CR < 0.1$, then it passes the consistency test. If not, it is not a reasonable index weight.

#### 3.1.1. First Level Index Weight

**Table 1. First Level Index ANP Weight**

| Target A | B1 | B2 | B3 | B4 | Weight |
|---|---|---|---|---|---|
| Policy Factor B1 | 1 | 1/3 | 6 | 3 | 0.5541 |
| Risk Factor B2 | 3 | 1 | 6 | 5 | 0.2840 |
| Technical Factor B3 | 1/6 | 1/6 | 1 | 1 | 0.0730 |
| Market Factor B4 | 1/3 | 1/5 | 1 | 1 | 0.0889 |

Calculate the maximum eigenvalue $\lambda_{max} = 4.1315$ , the corresponding weight value recorded as matrix $U = (0.5541 \quad 0.2840 \quad 0.0730 \quad 0.0889)^T, CI = 0.04383$ , $RI = 0.96$ , $CR = 0.04566$ . CR is less than 0.1 so the weight passes the test of consistency.

### 3.1.2. Second Level Index Weight

**Table 2. B1 Factor ANP Weight**

| B1 | C1 | C2 | C3 | C4 | Weight |
|---|---|---|---|---|---|
| Financial allocation proportion C1 | 1 | 3 | 7 | 5 | 0.5536 |
| Preferential tax policy C2 | 1/3 | 1 | 6 | 4 | 0.2890 |
| Efficiency of resources allocation in science& technology C3 | 1/7 | 1/6 | 1 | 1/3 | 0.0513 |
| Proportion of bank loans C4 | 1/5 | 1/4 | 3 | 1 | 0.1061 |

Calculate the maximum eigenvalue $\lambda_{max} = 4.1725$ , the corresponding weight value recorded as matrix $U1 = (0.5536 \quad 0.2890 \quad 0.0513 \quad 0.1061)^T, CI = 0.0575$ , $RI = 0.96$ $RI = 0.96$ ,. CR is less than 0.1 so the weight passes the test of consistency.

**Table 3. B2 Factor ANP Weight**

| B2 | C5 | C6 | Weight |
|---|---|---|---|
| Total risk investment capital C5 | 1 | 3 | 0.75 |
| Number of venture capital institutions C6 | 1/3 | 1 | 0.25 |

Calculate the maximum eigenvalue $\lambda_{max} = 2$ , the corresponding weight value recorded as matrix $U2 = (0.7500 \quad 0.2500)^T, CI = 0$ , $RI = 0$ , $CR = 0$ ,. CR is less than 0.1 so the weight passes the test of consistency.

**Table 4. B3 Factor ANP Weight**

| B3 | C7 | C8 | C9 | C10 | Weight |
|---|---|---|---|---|---|
| Transformation rate of science achievements C7 | 1 | 2 | 4 | 2 | 0.4337 |
| Technology innovation potential C8 | 1/2 | 1 | 3 | 1 | 0.2389 |
| Industry aggregation C9 | 1/4 | 1/3 | 1 | 1/3 | 0.0886 |
| Advanced technology C10 | 1/2 | 1 | 3 | 1 | 0.239 |

Calculate the maximum eigenvalue $\lambda_{max} = 4.0206$ , the corresponding weight value recorded as matrix: $U3 = (0.4337 \quad 0.2390 \quad 0.0886 \quad 0.23898)^T, CI = 0.0072$ , $RI = 0.96$ , $CR = 0.0075$ . CR is less than 0.1 so the weight passes the test of consistency.

 

**Table 5. B4 Factor ANP Weight**

| B4 | C11 | C12 | C13 | C14 | Weight |
|---|---|---|---|---|---|
| Number of listed science &technology enterprises C11 | 1 | 3 | 1/5 | 1/4 | 0.1149 |
| Capital scale of science& technology enterprises C12 | 1/3 | 1 | 1/6 | 1/5 | 0.0596 |
| Science and technology talent specialization C13 | 5 | 6 | 1 | 2 | 0.5033 |
| Number of science& technology banks C14 | 4 | 5 | 1/2 | 1 | 0.3222 |

Calculate the maximum eigenvalue $\lambda_{max} = 4.1323$ , the corresponding weight value recorded as matrix: $U4 = (0.5536 \quad 0.2890 \quad 0.0513 \quad 0.1061)^T$, $CI = 0.0459$ , $RI = 0.96$ , $CR = 0.0478$ . CR is less than 0.1 so the weight passes the test of consistency

### 3.2. Establish Fce Matrix

Before using the fuzzy comprehensive evaluation, we needs to establish the fuzzy evaluation matrix. Due to the characteristics of technology and finance in western area, this paper established fuzzy evaluation matrix evaluation method by Delphy, judge second level indicators to establish the fuzzy evaluation matrix, $V_i$ , $i = 1,2,3,4$ . Evaluation value has five grades: excellent, good, medium, poor, bad. The fuzzy evaluation matrixes are as follows:

$$V1 = \begin{pmatrix} 0.1 & 0.2 & 0.4 & 0.3 & 0.0 \\ 0.1 & 0.2 & 0.4 & 0.4 & 0.0 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \end{pmatrix} \qquad V2 = \begin{pmatrix} 0.2 & 0.0 & 0.3 & 0.3 & 0.2 \\ 0.1 & 0.2 & 0.3 & 0.2 & 0.2 \end{pmatrix}$$

$$V3 = \begin{pmatrix} 0.1 & 0.1 & 0.4 & 0.4 & 0.0 \\ 0.2 & 0.3 & 0.3 & 0.2 & 0.0 \\ 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \\ 0.1 & 0.1 & 0.3 & 0.5 & 0.0 \end{pmatrix} \qquad V4 = \begin{pmatrix} 0.3 & 0.1 & 0.2 & 0.4 & 0.0 \\ 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0.1 & 0.2 & 0.3 & 0.4 & 0.0 \\ 0.1 & 0.1 & 0.3 & 0.5 & 0.0 \end{pmatrix}$$

### 3.3. Fuzzy Comprehensive Evaluation

Based on the above calculation, the fuzzy comprehensive evaluation matrix Table is shown in Table 6:

**Table 6. Fuzzy Comprehensive Evaluation Matrix**

| Target layer | First level index (weight) | Second level index | Second level index weight | Evaluations | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Excellent | Good | Medium | Poor | Bad |
| A | B1 (0.5541) | C1 | 0.5536 | 0.1 | 0.2 | 0.4 | 0.3 | 0 |
| | | C2 | 0.289 | 0.1 | 0.2 | 0.4 | 0.4 | 0 |
| | | C3 | 0.0513 | 0.1 | 0.3 | 0.3 | 0.2 | 0.1 |
| | | C4 | 0.1061 | 0.1 | 0.2 | 0.3 | 0.3 | 0.1 |
| | B2 (0.2840) | C5 | 0.75 | 0.2 | 0 | 0.3 | 0.3 | 0.2 |
| | | C6 | 0.25 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 |
| | B3 (0.0730) | C7 | 0.4337 | 0.1 | 0.1 | 0.4 | 0.4 | 0 |
| | | C8 | 0.2389 | 0.2 | 0.3 | 0.3 | 0.2 | 0 |
| | | C9 | 0.0886 | 0.1 | 0.2 | 0.3 | 0.3 | 0.1 |
| | B4 (0.0889) | C10 | 0.239 | 0.1 | 0.1 | 0.3 | 0.5 | 0 |
| | | C11 | 0.1149 | 0.3 | 0.1 | 0.2 | 0.4 | 0 |
| | | C12 | 0.0596 | 0.1 | 0.1 | 0.3 | 0.4 | 0.1 |
| | | C13 | 0.5033 | 0.1 | 0.2 | 0.3 | 0.4 | 0 |
| | | C14 | 0.3222 | 0.1 | 0.1 | 0.3 | 0.5 | 0 |

First fuzzy comprehensive evaluation:

First of all, multiply the second level index weight and fuzzy evaluation matrix in turn, get the judgment matrix,

$$R = (r_1, \cdots r_i, \cdots), \quad i = 1,2,3,4 \ \textit{i.e.},$$

$$r_i = U_i^{\tau} \times V_i \tag{1}$$

So,

$$r_1 = U_1^{\tau} \times V_1 = \begin{pmatrix} 0.5536 \\ 0.2890 \\ 0.0513 \\ 0.1061 \end{pmatrix}^{\tau} \begin{pmatrix} 0.1 & 0.2 & 0.4 & 0.3 & 0.0 \\ 0.1 & 0.2 & 0.4 & 0.4 & 0.0 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \end{pmatrix}$$

$$= (0.1000 \quad 0.2051 \quad 0.3843 \quad 0.3238 \quad 0.1057)$$

Followed by above calculation, we get R2, R3, R4 to compose judgment matrix R.

$$R = \begin{pmatrix} 0.1000 & 0.2051 & 0.3843 & 0.3238 & 0.1057 \\ 0.1750 & 0.0500 & 0.3000 & 0.2750 & 0.2000 \\ 0.1239 & 0.1567 & 0.3434 & 0.3673 & 0.0089 \\ 0.1230 & 0.1503 & 0.2885 & 0.4322 & 0.0060 \end{pmatrix}$$

Second fuzzy comprehensive evaluation: multiply first level index weight and judgment matrix R, get the final evaluation matrix Z, *i.e.*,

$$Z = U^{\tau} \times R \tag{2}$$

$$Z = U^{\tau} \times R = \begin{pmatrix} 0.5541 \\ 0.2840 \\ 0.0730 \\ 0.0889 \end{pmatrix}^{\tau} \begin{pmatrix} 0.1000 & 0.2051 & 0.3843 & 0.3238 & 0.1057 \\ 0.1750 & 0.0500 & 0.3000 & 0.2750 & 0.2000 \\ 0.1239 & 0.1567 & 0.3434 & 0.3673 & 0.0089 \\ 0.1230 & 0.1503 & 0.2885 & 0.4322 & 0.0060 \end{pmatrix}$$

$$= (0.1251 \quad 0.1527 \quad 0.3488 \quad 0.3227 \quad 0.0667)$$

Through the calculation, we can see that the maximum value is 0.3488. According to the maximum value principle, we select 0.3488 as the result of the evaluation. According

 

to the previous evaluation value, it means "medium", which explains that the technology and finance coordination ability of China's western regions is at medium level. From the first level indicators, the influence of the policy factor is the largest, which also plays an important role in science and technology and innovation as well as science and technology and finance in western region. Furthermore, from the final evaluation matrix Z, we can see that the corresponding value to the "poor" level is 0.3227 , close to 0.3488, which means that the coordination ability strictly is in the "poor" level, close to "medium" level.

## 4. Improvement Suggestions

### 4.1. Make Full Use of Government's Leading Role in the Coordination of Technology and Finance

During the construction of innovation-oriented city, governments in western regions have introduced a series of related science& technology policy, financial regulations, taxation and fiscal policies and willing to establish a set of R & D, testing, and manufacturing support system to realize the integration of system of science& technology, finance, manufacturing. Those policies and regulations have helped many cities make some achievements in the process of cooperation in technology and finance. But compared with eastern coastal area of China and foreign countries, they are still in the growth stage. The government should strengthen its efforts to put forward more policies in terms of science & technology and finance, give full play to its leading role, and actively learn advanced experience both at home and from abroad. The government should also take effective measures to support high-tech enterprises and to create a fair competition environment for scientific and technological innovation as well as provide better financial security.

### 4.2. Establish Professional Technology Bank

Science and technology bank is the important carrier of financial capital and hi-tech resources. Some provinces and cities in the western region have established specialized technology banks, which have played important synergies. But the number of science& technology banks is relatively small. And new professional technology banks still need to be set up. Therefore, the business scope of existing technology bank should be expanded. The number of technology bank should be increased.

### 4.3. Make Innovations of Commercial Banks' Support Mode to High-Tech Enterprises

Commercial banks can take advantage of their service network and give financial aid to high-tech enterprise of good market prospect or quasi listed joint-stock enterprises or listed high-tech enterprises. They can also issue bonds to high-tech enterprises to establish direct links between the private investment funds and high-tech enterprises. Besides, they can play an intermediary role to help enhance relationship between bank and enterprises. Commercial banks should actively improve the pilot work of short-term financial bonds, securities and collection notes in financial industry. They can issue high-yield bond compliance with strategic science& technology industry to improve the financing capacity of enterprises.

### 4.4. Establish Risk Evaluation System of Technology Innovation

At present, the innovation of science &technology has high risk, so a sound risk evaluation mechanism of technical innovation should be gradually establish. Risk identification and assessment work are undertaken mainly by insurance companies and banks. What insurance companies underwrite is no longer a separate risk, but enterprises' debt-paying ability. In the technological enterprises, debt-paying ability is closely related to innovation and marketization process, which is influenced by various complex factors. So it is difficult to identify and evaluate. The insurance companies and the banks can try establishing the professional evaluation system of technology risk with research institutes and other related academies, scientifically evaluating the innovation risk of high tech enterprise and giving full play to risk trial.

### 4.5. Cultivate Professional Technological and Financial Talent

Collaborative development needs comprehensive talents. West region should attract innovative talents in technology and finance in view of globalization and construct professional and innovative team of science and finance. The science& technology and finance talents strategy should be closely combined with the coordinated development.

## 5. Conclusions

With West Development Strategy gradually implemented, technology and finance has become the inevitable choice of adjusting economic structure transforming into conservation-oriented economy. Considering the characteristics of technology and finance in western region, this paper established an evaluation index system. With the help of ANP and decision-making software Super Decisions, this paper determined the weight values of the established evaluation system, followed by the construction of fuzzy evaluation matrix. Finally, this paper used ANP-FCE model to evaluate the collaborative capability of technology and finance in western regions. Conclusion is that coordination ability of technology and finance in west area is at medium level. And improvement suggestions are put forward on further collaborative development of science& technology innovation and science& technology and finance in the future of China's western region.

The combination of ANP method with FCE method for evaluation of technology and finance in western area can reduce excessive qualitative judgment caused by subjective factors in AHP method so as to obtain more accurate weight value. The paper used fuzzy comprehensive evaluation method to operate the matrix twice and quantitatively deal with the results. Because of many factors influencing the judgment, the factors involved in the design of the indicator system cannot be listed. There is still a lot need to be improved, and this is also the direction the authors of this paper need to study and research in the future.

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## References

[1] M. Chu and Z. Li, "The report of technology and finance in Shanghai for the year", Chinese financial and Economic Publishing House, **(2013)**.
[2] C. Guo, "Science and technology innovation and national innovation", Beijing, Learning Publishing House, **(2002)**.
[3] A. N. Paralikas and A. I. Lygeros, "A multi-criteria and fuzzy logic based methodology for the relative ranking of the fire hazard of chemical substances and installations", Process Safety and Environment Protection, vol. 83, no. 2, **(2005)**, pp. 122-134.
[4] H. Wang and X. Yang, "A method to determine the combination weights based on AHP-RS", China of safety science and technology, vol. 6, no. 6, **(2010)**, pp. 155-160.
[5] D. Du, "Modern comprehensive evaluation method and case selection (Second Edition)", Beijing: Tsinghua University press, **(2008)**.
[6] J. Wang and Z. Chen, "Improved AHP- multi level fuzzy comprehensive evaluation method on Graduates' herd mentality", Journal of Chongqing Academy of Arts and Sciences (NATURAL SCIENCE EDITION), vol. 30, no. 1, **(2011)**, pp. 9-12.
[7] S. Song and F. Dai, "10 Research on fuzzy classification of emergencies and clustering analysis based on analytic hierarchy", Scientific decision, **(2010)**, pp. 68-72.
[8] M. Wei, "The study on enterprise technological innovation ability evaluation system and ANP method", Chongqing, Chongqing University, **(2006)**.
[9] Y. Meng, "(3) Regional science and technology innovation and evaluation index system research", Market weekly, **(2005)**.
[10] Y. Lin, "(4) A review of research on Chinese regional innovation system", Science and technology management research, **(2002)**.

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