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AHP-Fuzzy Comprehensive Evaluation Model of Venture Investment and Financing System: Based on the Case of Incubation Base in Anhui

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Abstract

Establish and improve the venture investment and financing system is an important issue of economic growth in China. By reference to the stakeholder theory, we select first grade assessment indicators including government policy factor, financial institutions factor, intermediary service factor, enterprises factor and other factors (risk investment funds, insurance funds, private capital) and second grade assessment indicators. The evaluation index system was constructed to the venture investment and financing system of China. We analyze new ventures in Anhui incubation base by AHP method and fuzzy comprehensive evaluation method. The results show that: The intermediary service system performed quite well in the evaluation, while government factor, financial institutions factor, enterprises factor and other factors perform poorly. So the overall performance of the system is in mediocre level. Finally some relevant recommendations are put forward to optimize the venture investment and financing system.

Key words: Venture; Investment and financing system; Index system; AHP; Fuzzy comprehensive evaluation method

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INTRODUCTION

Entrepreneurship is the engine of Chinese economic development. Since the reform and opening up, the most part of growth in GDP comes from the ventures. Chinese government has attached great importance to the entrepreneurial financial support and policy support, thus gradually formed a multiple levels of venture investment and financing system.

Many domestic and foreign scholars had to research entrepreneurship problem from the perspective of capital financing, but little from the perspective of the overall investment and financing system to find the weakness of the system to give suggestions. In this paper, we based on the fuzzy comprehensive evaluation method; study the venture investment and financing system in Anhui Province. Construct the investment and financing system model of ventures on the basis of quantitative analysis. Last, we give some suggestions to this problem.

1. CONSTRUCTION OF THE MODEL

Fuzzy comprehensive evaluation method is a comprehensive evaluation method based on fuzzy mathematics. The method can evaluate the objects which are difficult to quantify directly. It is widely used in expert grading system, quality control, weather forecast, and the field of economic management. This method has clear results with strong characteristics of the system, can provide comparable basis for decision-makers and improve the effectiveness of decision. Factors affecting the operation of venture investment and financing system do not have explicit outreach boundary. So the fuzzy comprehensive evaluation method is applicable to establish the evaluation model.

In order to carry out the comprehensive evaluation, ensure the concise of index setting and easily acquired data, we based on the stakeholder theory to make an analysis. We use the Delphi method to make a quantitative analysis, also known as the expert scoring method. This method can concentrate the consciousness and experience of experts. Then, by constantly revised and feedback, we finally obtain the satisfied conclusion.

1.1 The Evaluation Index System of Venture Investment and Financing System

The perfect operation of the venture investment and financing system needs the relevant subject of the whole system and varies factors could develop coordinately. The current evaluation index system of venture investment and financing system involves the following first class indicators, and second class indicators.

1.1.1 The Government Sector Index (U_{1i})

(a) Regulations level (U_{11}). Normalize venture's behavior, standardized and institutionalized the activity of ventures and other relevant subject.

(b) Science of evaluation system (U_{12}). There are so many ventures in China, their orientation, categories, and characteristics are different. They are trending diversification and specialization. So the evaluation system of government is different. Our quantitative evaluation index system must ensure the objectivity and fairness.

(c) Financial funds (U_{13}). The economics of financial production function theory shows that the increasing funds will significantly improve the development of ventures.

(d) Allocation of financial funds (U_{14}). The reasonable allocation of funds can promote the collaborative development of ventures, improve the competitiveness power of ventures.

1.1.2 Financial Institutions Factor (U_{2i})

(a) Interest rate adjustment ability (U_{21}). Bring money for the optimization of the industrial structure of accumulation.

(b) Credit support level (U_{22}). This could promote the industrial optimization system.

(c) Credit capital efficiency (U_{23}). Improve the efficiency of capital financial service capacity

(d) The policy financial support (U_{24}). The financial industry and new ventures develop coordinately.

(e) A reasonable degree of financial structure (U_{25}). Enhance the competitiveness of financial institutions.

(f) The degree of market (U_{26}).

1.1.3 Intermediary Service Factor (U_{3i})

(a) The authority and impartiality of intermediary organization (U_{31}). Enhance the public trust of entrepreneurial enterprise investment and financing system.

(b) Transparency of intermediary organization transparency (U_{32}). We should We should take advantage of the supervision ability of public.

(c) Service level of intermediary (U_{33}). Intermediary organization should improve their service efficiency.

(d) Loan guarantees (U_{34}). Ensure the cash flow of new ventures.

(e) Operation efficiency (U_{35}). Achieve the high efficiency of the investment and financing system.

1.1.4 Enterprises Factor (U_{4i})

(a) The scale of the enterprise (U_{41}). The scale of the enterprise can enhance the risk resisting ability.

(b) Enterprise credit (U_{42}). Enterprise credit is the premise of refinancing.

(c) The core competence of enterprises (U_{43}). The core competence of enterprises is fundamental to competitiveness of ventures.

1.1.5 Other Factors (U_{5i})

Risk investment funds (U_{51}), Insurance funds (U_{52}), Private capital (U_{53}). The above three kind of capital can not only bring money, also can bring their respective advantages. For example, risk investment capital could bring advanced management experience to motivate the modernization of venture, insurance funds could spread the risk, and private capital could bring corresponding innovation vigor.

1.2 Determine the Weight of Each Indicator by the AHP Method

In order to assure the actual situation of the indicators which reflect the research problem set in this analysis, we empower the weight of each indicator respectively. Previous studies usually use expert valuation method or the method of questionnaire to determine the indicators' weight, the former is too subjective, the latter does not further refine the data. This paper processed the data with the following steps: Firstly, eliminate the subjectivity of data come from the questionnaire survey; secondly, we use AHP analytic hierarchy process to calculate the weights of each indicators. AHP level analysis method has the advantage that it does not compare all the factors and does not give qualitative conclusions. But it uses the judgment matrix to conduct multiple comparisons, namely the relative materiality of all elements in one layer with the other layer, they are compared with the relative scale, which can overcome the difficulty of comparison between the elements has different nature. So the method could improve accuracy of research. According to the psychologist's conclusion, each layer elements should not be more than 9, the two class indicators constructed in this paper have not more than 9. For example, $W = (w_1, w_2, ..., w_n)$, $w_1+w_2+...+w_n=1$, W is the ranking vector which reflect the relative importance of the various elements, given $a_{ij}= w_i / w_j$, it means the relative importance of indicator I to indicator j. Then we construct the judgment matrix A.

$$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}=\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix}$$

From the result of above matrix,

$$Aw=\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix}\begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}=n\begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}$$

Then we know $Aw=nw$,$(A-nI)w=0$.

Let λ_{max} become the maximum characteristic root of matrix A, its feature vector is the weight vector w.$Aw=\lambda_{max}w$, thus obtain w, and determine the weight of each evaluation indicator.

1.3 Fuzzy Comprehensive Evaluation Model of the Venture Investment and Financing System

1.3.1 Establish the Evaluation Result Set

$V=\{V_1,V_2,V_3,V_4,V_5\}$. See Table 1.

Table 1
The Evaluation Grade of the Venture Investment and Financing Syste

Perfect	Good	General	Poor	Very poor
V_1	V_2	V_3	V_4	V_5
8~10	6~8	4~6	2~4	0~2

1.3.2 Determine the Evaluation Factor Set and Participating Elements Set of Evaluation Factors

(a) Evaluation factor set：$U=\{U_1,U_2,U_3,U_4,U_5\}$.

(b) Select participating elements set of evaluation factors:

$U_{1i}=\{U_{11},U_{12},U_{13},U_{14}\}$,
$U_{2i}=\{U_{21},U_{22},U_{23},U_{24},U_{25},U_{26}\}$,
$U_{3i}=\{U_{31},U_{32},U_{33},U_{34},U_{35}\}$,
$U_{4i}=\{U_{41},U_{42},U_{43}\}$,
$U_{5i}=\{U_{51},U_{52},U_{53}\}$.

1.3.3 Construct the Fuzzy Matrix According to the Degree of Membership

Fuzzy matrix means the fuzzy relation between evaluation index and evaluation class：

$$R_{ij}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}.$$

Then obtain the comprehensive degree of membership：$B=(b_1,b_2,\ldots,b_n)=W^T\cdot R_{ij}$,

$$b_j=\sum_{i=1}^{n} w_i r_{ij}.$$

1.3.4 Determine the Level According to the Principle of Maximum Degree of Membership

Normalized the comprehensive degree of membership, calculate the evaluation class of each indicator according to the grade value set above:

$$b_j'=\frac{b_j}{\sum_{j=1}^{m} b_j},\quad P_j=\sum_{j=1}^{m} b_j' V_j.$$

Comparing the final evaluation outcome with the interval level in the table, then confirm the overall performance of the venture investment and financing system in China.

2. A CASE STUDY OF THE VENTURE INVESTMENT AND FINANCING SYSTEM IN ANHUI

There are 5 famous incubation in Anhui Province, they are Hefei National University Science Park (2000), Anqing hi tech Innovation Service Center (2009), Tongling Students Pioneer Park (2011), Business Incubator of Anhui Finance and Economics University (2013), Business Incubator Base of College students in Hefei Economic and Technological Development Zone (2013). In the five famous incubations, there are more than 5,000 enterprises in these areas, including high-tech enterprises in the United States, Japan, Germany and other countries and regions, they set up more than 300 ventures, incubation 14 quoted corporation. We found that in these areas there are more than 120 new ventures have received or are receiving the IPO financing, seed funds, incubation fund, innovation fund and risk fund, bank loan, Anhui equity trusteeship trading center and other investment and financing service. We take incubations of Anhui province as an example, evaluate the comprehensive situation by combining the data of evaluation institutions and experts, reference to the weight of each indicator and comprehensive rating, obtain the financing indicator system.

2.1 Determine the Weight of First and Second Class Indicators

Take the four second class indicators as example, the process of determination of the weight as follows:

Table 2
The Comprehensive Indicator Score After Adjustment

2st class indicator	Financial funds w_1	Allocation of financial funds w_2	Regulations level w_3	Science of evaluation system w_4
score after adjustment	0.342845	0.297904	0.202764	0.157975

We can obtain the judgment matrix from Table 2:

$$A = \begin{bmatrix} 1 & w1/w2 & w1/w3 & w1/w4 \\ w2/w1 & 1 & w2/w3 & w2/w4 \\ w3/w1 & w3/w2 & 1 & w3/w4 \\ w4/w1 & w4/w2 & w4/w3 & 1 \end{bmatrix},$$

we calculate the maximum characteristic root of matrix A equal to 4 by means of MATLAB, the corresponding normalized feature vectors are $\begin{pmatrix} 0.342332 \\ 0.297462 \\ 0.20246 \\ 0.157747 \end{pmatrix}$, then the weight of financial funds is 0.342332, the weight of allocation of financial funds is 0.297462, the weight of regulations level is 0.20246, the weight of science of evaluation system is 0.157747.

In a similar way, we can obtain the weight of other indicators of 2st class, and obtain the 1st class indicators of the venture investment and financing system.

2.2 Evaluation of the Venture Investment and Financing System of Anhui

Integrated the data which calculated from the figures above, we get the following table of venture investment and financing system of Anhui (see Figure 3). To simplify the calculation, we take 3 digits after the decimal point.

Table 3
Summary Sheet of Venture Investment and Financing System of Anhui

1st indicators	Weight	2st indicators	Weight	Assessment level				
				Perfect	Good	General	Poor	Very poor
The government sector indicators	0.144	Regulations level	0.202	0.20	0.50	0.20	0.05	0.05
		Science of evaluation system	0.158	0.20	0.20	0.30	0.15	0.15
Financial institutions factors	0.243	Financial funds	0.342	0.35	0.20	0.20	0.15	0.10
		Allocation of financial funds	0.297	0.15	0.20	0.25	0.30	0.10
		Interest rate adjustment ability	0.453	0.10	0.10	0.50	0.20	0.10
		Credit support level	0.106	0.05	0.15	0.50	0.20	0.10
		Credit capital efficiency	0.128	0.10	0.10	0.40	0.30	0.10
		The policy financial support	0.163	0.10	0.20	0.40	0.20	0.10
		A reasonable degree of financial structure	0.027	0.05	0.05	0.10	0.60	0.20
Intermediary service factors	0.311	The degree of market	0.123	0.10	0.15	0.30	0.25	0.20
		The authority and impartiality of intermediary organization	0.173	0.30	0.20	0.35	0.05	0.10
		Transparency of intermediary organization transparency	0.314	0.20	0.40	0.25	0.10	0.05
		Service level of intermediary	0.362	0.40	0.20	0.20	0.10	0.10
Enterprises factors	0.206	Loan guarantees	0.064	0.25	0.25	0.30	0.15	0.05
		Operation efficiency	0.087	0.35	0.35	0.15	0.10	0.05
		The scale of the enterprise	0.297	0.15	0.25	0.30	0.20	0.10
		Enterprise credit	0.269	0.30	0.30	0.25	0.10	0.05
		The core competence of enterprises	0.434	0.35	0.20	0.15	0.15	0.15
Other factors	0.096	Risk investment funds	0.167	0.10	0.20	0.2	0.40	0.10
		Insurance funds	0.561	0.20	0.30	0.25	0.15	0.10
		Private capital	0.272	0.10	0.15	0.40	0.25	0.10

According to Table 3, we evaluate each factor by Fuzzy Comprehensive Evaluation method.

2.2.1 The Government Sector Indicators

W_1=[0.202, 0.158, 0.342, 0.297]

$$R_1 = \begin{bmatrix} 0.2 & 0.5 & 0.2 & 0.05 & 0.05 \\ 0.2 & 0.2 & 0.3 & 0.15 & 0.15 \\ 0.35 & 0.2 & 0.2 & 0.15 & 0.1 \\ 0.15 & 0.2 & 0.25 & 0.3 & 0.1 \end{bmatrix}$$

=>The membership degree vector:

$B_1 = W_1R_1$ = [0.2363, 0.2604, 0.2304, 0.1742, 0.0977].

Normalized:

B_1'=[0.2365, 0.2607, 0.2307, 0.1744, 0.0978].

P_1= = 5.7279,

$P_1 \in$ [4, 6].

So the performance of government sector is in mediocre level, the function of government in the venture investment and financing system need to be enhanced.

2.2.2 Financial Institutions Factors

W_2=[0.453, 0.106, 0.128, 0.163, 0.027, 0.123]

=> The membership degree vector:

$B_2 = W_2R_2$ = [0.0934, 0.1264, 0.4355, 0.2298, 0.115].

Normalized:

B_2'= [0.0933, 0.1264, 0.4355, 0.2297, 0.115],

$P_2 = \sum_{j=1}^{m} bj'Vj$ = 4.7061,

$P_2 \in$ [4,6].

So the performance of financial institutions factors is in mediocre level, the function of financial institutions in the venture investment and financing system need to be enhanced.

2.2.3 Intermediary Service Factors

W_3=[0.173, 0.314, 0.362, 0.064, 0.087]

=> The membership degree vector:

$B_3 = W_3R_3$ = [0.306, 0.279, 0.2437, 0.0946, 0.0768].

Normalized:

B_3'=[0.306, 0.279, 0.2437, 0.0946, 0.0768],

$P_3 = \sum_{j=1}^{m} bj'Vj$ = 6.2861,

$P_3 \in$ [6, 8].

So the performance of intermediary service factors is quiet well.

2.2.4 Enterprises Factor

W_4=[0.297, 0.269, 0.434]

=> The membership degree vector:

$B_4 = W_4R_4$ = [0.2772, 0.2418, 0.2215, 0.1514, 0.1083].

Normalized:

B_4'=[0.2772, 0.2418, 0.2215, 0.1514, 0.1083],

$P_4 = \sum_{j=1}^{m} bj'Vj$= 5.8574,

$P_4 \in$ [4, 6].

So the performance of enterprises factors is in mediocre level, the function of intermediary service in the venture investment and financing system need to be enhanced.

2.2.5 Other Factor

W_5=[0.167, 0.561, 0.272]

=> The membership degree vector:

$B_5 = W_5R_5$ = [0.1561, 0.2425, 0.2825, 0.219, 0.1].

Normalized:

B_5'=[0.1561, 0.2425, 0.2825, 0.219, 0.1],

$P_5 = \sum_{j=1}^{m} bj'Vj$= 5.2719,

$P_5 \in$ [4, 6].

So the performance of other factors is in mediocre level, the function of other factors in the venture investment and financing system need to be enhanced.

2.2.6 The Overall Evaluation of the Venture Investment and Financing System

$$R=[B_1,B_2,B_3,B_4,B_5]^T = \begin{bmatrix} 0.2365 & 0.2607 & 0.2307 & 0.1744 & 0.0978 \\ 0.0933 & 0.1264 & 0.4355 & 0.2297 & 0.115 \\ 0.306 & 0.279 & 0.2437 & 0.0946 & 0.0768 \\ 0.2772 & 0.2418 & 0.2215 & 0.1514 & 0.1083 \\ 0.1561 & 0.2425 & 0.2825 & 0.219 & 0.1 \end{bmatrix},$$

=> The membership degree vector:

$B = [b_1, b_2, \ldots, bn] = WR$ = [0.224, 0.2281, 0.2876, 0.1626, 0.0978].

Normalized:

B'=[0.224, 0.228, 0.288, 0.163, 0.098],

$P = \sum_{j=1}^{m} bj'Vj$= 5.639,

$P \in$ [4, 6].

So the overall performance of the system is in mediocre level.

CONCLUSION

Through the above analysis we found that governments, financial institutions, enterprises, and other factors in the system are not perfect, while the intermediary service system is sound .This is consistent with the present state that there are more than 80 relevant agencies which are engaged in various intermediary service(like technical consulting, property transactions, assets assessment etc.) in these incubations. This leads to the overall general performance of the venture investment and financing system of Anhui. So it is urgent to improve the venture investment and financing system. And we should take effective measures from perspectives of governments, financial institutions, venture enterprises and other factors to optimize this comprehensive system, and we should further enhance the role of intermediary agencies too.

Some relevant suggestion to this problem:

a) Take active measures to optimize the policy system.

b) Improve the function of financial system.

c) Intensify the intermediary service system.

d) Improve the financial ability of enterprise and improve the credit level of enterprises.

e) Regulate the other capitals.

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