Research on Risk Assessment of Venture Project Based on The Improved AHP

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Abstract. Innovative venture projects have a high risk, this paper, establishing a comprehensive evaluation model, analysed these factors that affect innovation and entrepreneurship and evaluated the risk of entrepreneurship quantitatively. First, through improving the AHP method, avoiding consistency checking and blindness in the standard AHP, the improved AHP method was used to determine the weights of the indicators at all levels. Then, uniting the fuzzy comprehensive evaluation results to obtain the evaluation results of risk of venture project, so as to play a guiding role for risk management of innovation and entrepreneurship. The result of empirical research indicates that the improved AHP method is strongly scientific, practical and effective, thus it is worthy being popularized and applied on risk assessment and risk management of innovative and entrepreneurial projects.

1. Introduction
Scientific and reasonable assessment of the risks in the process of innovation and entrepreneurship has been a long-term discussion for entrepreneurs[1-3], this can provide decision-making basis for innovation and entrepreneurship. Risk assessment of innovation and entrepreneurship is a typical multi-level, multi-factor problem of comprehensive evaluation, it is very important to determine the weight of each influencing factor in the process of evaluation, it is directly related to the rationality and authenticity of the risk assessment [4].

The traditional AHP method is introduced in this paper. On the basis of this, the AHP method is improved. The improved AHP method is applied to the risk assessment of innovation and entrepreneurship project. Firstly, establish the subjective judgment matrix. Then, an objective judgment matrix is established based on the relationship between subjective and objective, the weight of each influencing factor is obtained by normalization. Finally, through the fuzzy comprehensive evaluation method, the evaluation result of the risk of venture project is obtained. This is of great theoretical and practical value for risk assessment and risk management of innovative and entrepreneurial projects.

2. The Establishment of the Model of Three-scale Fuzzy AHP
Traditional AHP usually uses nine scales to represent the comparative judgment of the importance of indicators, but in practice, there are great difficulties[5]. We improve the traditional AHP, the concrete idea is to construct the comparison matrix by using the more intuitive three-scale method, and then convert it into the subjective judgment matrix. The subjective judgment matrix is transformed into the
objective judgment matrix through the relationship between the subjective factor and the objective factor, so that the objective judgment matrix naturally meets the requirement of consistency, to avoid the test and adjustment of consistency. Finally, the weight of the index is calculated through the square root method.

2.1. The establishment of the objective judgment matrix

2.1.1. The establishment of a comparison matrix: Assuming that there are n elements at the same level, compared to a certain element in the upper, the decision maker can obtain the comparison matrix $C = (c_{ij})_{n \times n}$, Through comparing the importance of two elements using the improved AHP, where

$$
c_{ij} = \begin{cases} 
0, & \text{the i-th element is not as important as the j-th element,} \\
1, & \text{the i-th element is as important as the j-th element} \\
2, & \text{the i-th element is more important than the j-th element,}
\end{cases}
$$

(1) and $c_{ii} = 1$, i.e., the elements themselves are of the same importance.

2.1.2. The establishment of a comparison matrix. According to the comparison matrix $C = (c_{ij})_{n \times n}$, calculate the each factor’s ranking index of importance

$$
\gamma_i = \sum_{j=1}^{n} c_{ij}, \quad (i=1,2,\ldots,n)
$$

(2) $\gamma_i$ denotes the overall importance of the i-th factor, let $s_{ij} = \gamma_i - \gamma_j$, then the subjective judgment matrix is obtained

$$
B = [s_{ij}]_{n \times n}
$$

(3)

2.1.3. The establishment of objective judgment matrix. According to the law of G. T. Fechner[6], sensation quantity $s$ and stimulus objective quantity $r$ subject to the following relationship:

$$
s = k \lg r
$$

(4) In the equation: $k$ is a constant, assuming that the objective judgment matrix uses the q-scale (This paper uses three-scale, i.e. $q=3$), so,

$$
\exp \left( \frac{s_{\text{max}}}{k} \right) = q
$$

Then, $k = \frac{s_{\text{max}}}{\ln q}$ where $s_{\text{max}} = \max_{i \neq j} s_{ij}$, assuming the sensation quantities of importance of i and j are $s_i$, $s_j$ respectively, objective quantities of importance are $r_i$, $r_j$ respectively. Taking them into the equation of Fechner, the following equation is obtained:

$$
s_i - s_j = k \lg \left( \frac{r_i}{r_j} \right)
$$

(5)

Taking the natural logarithm:

$$
\frac{r_i}{r_j} = \exp \left( \frac{s_i - s_j}{k} \right)
$$

(6) we obtain that the ratio of the objective quantities of importance $(r_i, r_j)$ is exponential function of the difference between sensation quantities $(s_i, s_j)$. Therefore, the objective judgment matrix is established based on the ratio of factor importance:

$$
Q = [r_{ij}]_{n \times n}
$$

(7) Where, $r_{ij} = \exp \left( \frac{s_{ij}}{k} \right) = \exp \left( \frac{(\gamma_i - \gamma_j)}{k} \right) = \frac{r_i}{r_j}$, It can be seen that any two columns of the objective judgment matrix formed here are linearly related, this judgment matrix is consistent with the decision thinking of people, thus, avoiding the test of consistency.

2.2. The determination of the weight
Based on the objective judgment matrix established above, in order to simplify the calculation, this paper uses the approximate square root method[7], the steps are as follows:

Firstly, calculating the product of the elements of \( Q_{ij} \)'s each row

\[
M_i = \prod_{j=1}^{n} r_{ij} \quad (i=1,2,\ldots,n)
\]  

(8)

Then, calculating the square root

\[
\sqrt{W_i} = \frac{M_i}{\sqrt{n}}
\]  

(9)

Finally, making normalized processing to \( W=(W_1, W_2, \ldots, W_n) \), i.e.

\[
\bar{W}_i = \frac{W_i}{\sum_{i} W_i}
\]  

(10)

So, \( W=(W_1, W_2, \ldots, W_n)^T \) is the weight vector which we want to achieve.

### 2.3. Fuzzy comprehensive evaluation method

L.A.Zadeh proposed the concept of fuzzy sets in 1965[8], the fuzzy comprehensive evaluation method was derived from the relevant theory[9]. In general, fuzzy comprehensive evaluation method has the following specific steps:

1. Determine the set of factors for the evaluation of the object \( U \). A factor set is a set of factors that evaluate the object \( U=\{u_1, u_2, \ldots, u_n\} \), among them, \( u_i \) \((i=1,2,\ldots,n)\) on behalf of the various factors. To some extent, these factors have different degrees of model.

2. Determine rating levels \( V \). The comment set is a collection of evaluations of the various factors of the evaluation object—level set, express as: \( V=\{v_1, v_2, \ldots, v_m\} \). \( v_j \) is a possible outcome for judgment, according to the specific circumstances of the subjective set.

3. Establish fuzzy relation matrix \( R \). Each factor in \( U \) is judged fuzzy, according to the grade index of the evaluation and getting the judgment matrix:

\[
R = \begin{bmatrix}
\hat{r}_{11} & \cdots & \hat{r}_{1m} \\
\vdots & \ddots & \vdots \\
\hat{r}_{n1} & \cdots & \hat{r}_{nm}
\end{bmatrix}
\]  

(11)

Among them, \( \hat{r}_{ij} \) represents \( U_i \) degree of membership in relation to \( V_j \). \((U,V,R)\) constitutes a fuzzy comprehensive evaluation model. Then, in some way, the importance index \( W \) and the evaluation matrix \( R \) are combined to evaluate the vector \( A \). In this paper, the inner product calculation method is used to determine the evaluation vector, indicated as:

\[
A = WoR
\]  

(12)

4. Analysis matrix \( A \). The weighted average membership method is used to rank the evaluated items according to the rank.

### 3. Establishment of evaluation index system for innovation and Entrepreneurship

Based on the analysis of the major risks to innovation and entrepreneurship projects and reference to the relevant literature[10-14]. Based on the principles of system, science, independence, risk control and so on. In this paper, the Delphi method[15], from the political, social, economic, legal and other aspects of screening, to identify the main risk factors to determine the key sub-risk factors, innovation and entrepreneurship risk is actually a multi-level, multi-factor of the system, so that the integrity of the index system and the use of indicators combined with the organic use.

According to the five major risks faced by innovation and entrepreneurship, the establishment of innovative and entrepreneurial project evaluation index system. As shown in Table 1.

### Table 1. Entrepreneurship project evaluation index system.

| Level 1 indicators | Level 2 indicators |
|--------------------|--------------------|
| Management risk    | Arbitrary decision making \( B_1 \) |
| \( A_i \)          | Misuse the person \( B_2 \) |
|                     | Team building \( B_3 \) |
| Technology risk    | Advanced technology \( B_4 \) |
### Application of Improved Analytic Hierarchy Process in Venture Project Risk Assessment

#### 4.1 Improved AHP Method to Determine the Weights of Evaluation Indexes

In this paper, an agricultural science and technology innovation and entrepreneurship project research professional interviewed. Analysing the importance of management project risk $A_1$, technology risk $A_2$, market risk $A_3$, resource risk $A_4$, policy risk $A_5$ and filling in the form, a comparison matrix with three scales is obtained:

$$C = \begin{pmatrix}
1 & 0 & 2 & 2 \\
2 & 1 & 2 & 2 \\
2 & 0 & 1 & 2 \\
0 & 0 & 0 & 1 \\
0 & 0 & 0 & 1
\end{pmatrix}$$

Importance ranking after calculation: $\gamma_1=5, \gamma_2=9, \gamma_3=7, \gamma_4=3, \gamma_5=1$.

The subjective judgment matrix is calculated by (5) and (6):

$$B = \begin{pmatrix}
0 & -4 & -2 & 2 & 4 \\
4 & 0 & 2 & 6 & 8 \\
2 & -4 & 0 & 2 & 6 \\
-2 & -4 & -6 & 0 & 2 \\
-4 & -8 & -6 & -2 & 0
\end{pmatrix}$$

According to (7) ~ (10), the objective judgment matrix is calculated:

$$Q = \begin{pmatrix}
1.000 & 0.577 & 0.760 & 1.317 & 1.733 \\
1.733 & 1.000 & 1.317 & 2.282 & 3.004 \\
1.317 & 0.760 & 1.000 & 1.733 & 2.282 \\
0.760 & 0.577 & 0.438 & 1.000 & 1.317 \\
0.577 & 0.333 & 0.438 & 0.760 & 1.000
\end{pmatrix}$$

Finally, the root weight method is adopted to calculate the weight vector by (11) and (12):

$$W = \left(0.190, 0.300, 0.243, 0.152, 0.115\right)$$

The index weights of each factor layer are obtained by the same method:

- $W_1 = \left(0.259, 0.282, 0.459\right)$
- $W_2 = \left(0.194, 0.564, 0.242\right)$
- $W_3 = \left(0.469, 0.255, 0.221, 0.055\right)$
- $W_4 = \left(0.463, 0.449, 0.088\right)$
- $W_5 = \left(0.147, 0.253, 0.446, 0.154\right)$

#### 4.2 Establishing a Risk Indicator Review Set

According to the actual situation definition of five grades of reviews, the specific content shown in Table 2.

| $A_2$ | Technical reliability $B_3$ | Technology research level $B_6$ |
|-------|-----------------------------|---------------------------------|
| Market risk $A_3$ | Project selection $B_7$ | Market exploitation $B_8$ | Market operation $B_9$ | Competitor $B_{10}$ |
| Resource risk $A_4$ | Network of contacts $B_{11}$ | Financing risk $B_{12}$ | Technical equipment $B_{13}$ |
| Policy risk $A_5$ | Laws and regulations $B_{14}$ | Policy consultation $B_{15}$ | Project evaluation $B_{16}$ | National tax $B_{17}$ |
Table 2. Risk assessment grading standards.

| Evaluation interval | Risk level  |
|---------------------|-------------|
| [100,80)            | Very high   |
| [80,60)             | High        |
| [60,40)             | Middle      |
| [40,20)             | Low         |
| [20,0)              | Very Low    |

4.3. Fuzzy comprehensive evaluation
The fuzzy comprehensive evaluation starts from the lower level of the whole index system, moves up layer by layer, establishes the single factor evaluation matrix from the lower level evaluation \( R_i \), obtains the first level evaluation vector \( A_i=W_i*R_i \). Then, seeing every \( A_i \) as a factor, the factor obtains the second evaluation vector: \( A=W^*R \).

4.3.1. Comprehensive evaluation of secondary indicators. The fuzzy evaluation matrix can be obtained from the second to the first level \( R_i (i=1,2,3,4) \),
\[
A_i=W_i*R_i=(0.587,0.283,0.103,0,0,0)
\]
The corresponding assessment level to give a certain score, "management risk" score for
\[
F_i=A_i*S^T=(0.587,0.283,0.103,0.027,0,0)*[90,70,50,30,10]^T=78.6
\]
Similarly calculated:
\[
A_1=(0.337,0.366,0.216,0.081,0) \quad F_1=69.18
\]
\[
A_2=(0.339,0.318,0.234,0.097,0.012) \quad F_2=67.5
\]
\[
A_3=(0.718,0.231,0.051,0) \quad F_3=83.34
\]
\[
A_4=(0.015,0.138,0.530,0.269,0.048) \quad F_4=46.06
\]

4.3.2. Make a comprehensive evaluation of the first level indicators. According to the weights obtained above and the results of single factor fuzzy comprehensive evaluation, the comprehensive evaluation set is obtained:
\[
A=W^*R=(0.341,0.292,0.210,0.084,0.073)
\]
The corresponding score:
\[
F=A*S^T=64.88
\]
This shows that the risk of agricultural technology start-ups is "high" level.

5. Compared with the standard AHP
In order to verify whether the improved AHP method is reasonable and more efficient, we use the standard AHP to calculate the index weight of the agricultural venture project. From the calculation results (see Table 3) can be seen, the ranking results of improved AHP method and the standard AHP method used in this paper to calculate the weights of exactly the same and the weight value is relatively close. Therefore, the weight calculation method is feasible and effective.

Table 3. Comparison of calculation results of two methods.

| Index            | Standard AHP | Rank | Improved AHP | Rank |
|------------------|--------------|------|--------------|------|
| Management risk  | 0.155        | 3    | 0.190        | 3    |
| Technology risk  | 0.325        | 1    | 0.300        | 1    |
| Market risk      | 0.264        | 2    | 0.243        | 2    |
| Resource risk    | 0.151        | 4    | 0.152        | 4    |
| Policy risk      | 0.105        | 5    | 0.115        | 5    |
Compared with the standard AHP method, the improved AHP method adopted in this paper has the following advantages:

1) The consistency checking in the standardized AHP method is avoided, which makes the whole process more convenient. At the same time, the blind adjustment is avoided, because the judgment matrix is inconsistent, which makes the results more reasonable.

2) The judgment matrix is constructed by the three-scale method, which reduces the difficulty of expert judgment and avoids the irrational results caused by the fuzzy judgment of the intermediate degree of 1--9 scale.

6.Conclusions
Aiming at the shortage of the standard AHP method, this paper puts forward the improved method of AHP; At the same time, the fuzzy comprehensive evaluation method of risk of agricultural science and technology entrepreneurial projects were evaluated to reduce the subjectivity of evaluation, making the evaluation results more objectively, which provides scientific basis for risk assessment and risk management of venture project.

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