

Research on Internet Financial Risk Based on Fuzzy Analytic

Hierarchy Process

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ABSTRACT: Internet finance is a new financial operation model that is accompanied by the rapid development of a new generation of information technology and represents the direction of reform and innovation in the traditional financial industry. Internet finance includes various development models such as third-party payment, P2P online lending, crowdfunding, big data finance, internet insurance, and internet financial portals. How to scientifically and effectively evaluate and monitor the risks of its development is an important issue for the future of Internet finance development. factor. The risks of internet finance include technical risks, credit risks, operational risks, legal regulatory risks, and other risks. The causes are complex and the characteristics are also diverse. The assessment methods include qualitative assessment, quantitative assessment, and comprehensive analysis. In order to promote the healthy, orderly and sustainable development of internet finance, the countermeasures to be taken include: establishing an internet financial knowledge system; building an internet financial network security system; establishing an internet finance credit risk management system; establishing and improving an internet financial operation risk management system Vigorously improve the Internet financial supervision and legal system.

KEYWORDS: *internet finance; risk assessment; risk monitoring; financial innovation*

I. INTRODUCTION

In recent years, along with the rapid development of technologies such as big data, cloud computing, mobile Internet, and the Internet of Things, human society is rapidly entering the era of "great wisdom moving the cloud". The financial industry – an ancient industry that is accompanied by human economic activities, on the one hand, the traditional financial industry is facing severe and complex challenges, and wherever it is concerned is receiving widespread attention; on the other hand, the integration of the Internet and the financial industry the "Internet Finance" developed in full swing is growing stronger and stronger. However, it cannot be overlooked that due to the ignorance of the perception of Internet financial risks, coupled with the lack of effective assessment and supervision of risks, various accidents caused by risk uncontrollable emerge in an endless stream, not only for the national financial system. Safety has brought serious harm, and it has also caused irreversible losses to a large number of investors and related parties, and even created more social unrest factors. Therefore, strengthening research on Internet financial risks and taking effective measures to prevent and respond to risks is not only important for safeguarding the healthy, rapid, and orderly development of Internet finance itself, but also for the security of the national financial system and each the protection of the interests of party participants is also closely related. This article systematically analyzes the problems related to Internet financial risks and aims to provide possible methods and basis for the improvement of Internet financial risk theory and the construction of a preventive system.

II. MAIN MODES AND TRENDS OF INTERNET FINANCE

Internet finance is a new concept that has emerged in recent years. Many scholars have seen their benevolences and wise men see wisdom. They are defined from different perspectives and it is difficult to form a consistent opinion. In essence, Internet finance is based on the Internet (including the PC Internet and mobile Internet), cloud computing, big data, and various types of intelligent terminals and other new-generation information technologies as the carrier to realize the financial industry and the Internet industry and the modern information technology industry. The process of integrating with each other, innovating financial formats and building a new model of financial services. There are mainly third-party payment, P2P lending, crowdfunding, big data finance, internet insurance, and internet financial portals [3].

III. THE MAIN PERFORMANCE OF INTERNET FINANCIAL RISK

Internet finance is in a period of explosive growth, and various forms of Internet financial services are showing a rush of competition. However, while seeing the rapid rise of internet finance, the risks implied by internet finance are also rapidly accumulating. If it is impossible to scientifically and rationally recognize all kinds of real and potential risks, once risks are out of control, they will inevitably give Internet finance. The future has a devastating impact. This article intends to systematically analyze the various risks faced by internet finance, hoping to provide basic evidence for risk assessment and prevention and control. The main risks of internet finance include: operational risk, technical risk, credit risk, operational risk, legal regulatory risk, and other risks.

IV. THE CAUSES AND MAIN CHARACTERISTICS OF INTERNET FINANCIAL RISK

Compared with traditional financial operations, the risks of Internet finance not only have their own causes, but also have different characteristics from traditional financial risks. As a new type of financial business operation model, Internet finance fully integrates a new generation of information technology and various financial services represented by the Internet, forming a new business operation model. The causes of risks include the following aspects: (1) Internet finance lacks corresponding standards and specifications, (2) existing regulatory systems cannot adapt to new business development requirements, and (3) complexity and rapid evolution of technology architectures have caused various risks to emerge. Strengthening risk prevention and control is a prerequisite for the healthy, rapid, and sustainable development of Internet finance. "Wind control is the king" is the primary criterion for determining the future and fate of Internet finance. Judging from the current form of Internet financial risk, it mainly has the following characteristics:(1) diversity of risks, (2) variability of risks, (3) multilateralism of risks, and (4) multiplicity of risk supervision [4].

V. Evaluation Method of Internet Financial Risk—Fuzzy Analytic Hierarchy Process

Needless to say, "risk" is an inherent attribute of internet finance. If you leave the risk, you will lose the meaning of internet finance. Therefore, for the development of internet finance, how to scientifically assess risks and thus be able to more effectively prevent and respond to all kinds of risks is a problem that relevant participants must face together. From the current point of view, in order to assess the overall risk of Internet finance, three methods, qualitative risk assessment method, quantitative risk assessment method, and comprehensive analysis risk assessment method, can be selected for evaluation. This paper mainly explores the fuzzy analytic hierarchy process in Internet financial risk assessment. Application.

Internet financial risk assessment is a very complex process. First, the weight of each indicator must be determined. Second, a fuzzy evaluation model should be established to conduct multi-level fuzzy evaluation. (No.1) Constructing an internet financial risk factor hierarchy model and indicator system The strategic target layer is internet finance risk, and the intermediate criteria layer is operational risk, technical risk, credit risk, operational risk, legal regulatory risk, and other risks. According to the above hierarchy model, we can determine that the first-level indicator of Internet financial risk is Internet financial risk, and the second-level indicators are operational risk, technical risk, credit risk, operational risk, legal regulatory risk, and other risks, as shown in Table 1[5].

Table 1 Internet Financial Risk Assessment Index System

First-level indicators	Secondary indicators
Internet Finance (A)	Operational risk (B1)
	Technical Risk (B2)
	Credit risk (B3)
	Operational Risk (B4)
	Legal Supervision Model (B5)
	Other risks (B6)

(No.2) After using fuzzy analytic hierarchy process to determine weights, establishing evaluation level model and evaluating index system, it is necessary to determine the weight of each index. Building a judgment matrix After establishing a hierarchical model of the Internet financial risk assessment indicator system, it is necessary to compare each layer of factors in twos and two to obtain quantitative results of corresponding importance and construct a judgment matrix to calculate weights.

(1) Build a judgment matrix

After establishing the hierarchical model of the Internet financial risk assessment index system, it is necessary to compare each layer of factors in twos and two to obtain the quantitative results of corresponding importance and construct a judgment matrix to calculate the weights.

Satty, a US operations researcher, proposed using the numbers 1 to 9 and their reciprocals as a scale for judging the relative importance of the two indicators, as shown in Table 2. In the table α_{ij} Expressed in the same layer of indicators, i Indicators and Number j The ratio of the influence of one index to the next is [1]. n When two factors are compared, they form a judgment matrix. $A = (\alpha_{ij})_{n \times n}$ And meet $\alpha_{ij} > 0, \alpha_{ii} = 1$.

Table 2 Satty AHP 1-9 Scale Table

α_{ij} (Scaling)	meaning
1	Indicates that two factors are equally important
3	Meaning that two factors are equally important
5	Indicates that the two factors are significantly more important than the former
7	It means that the two factors are more important than the former than the latter
9	Indicates that the two factors are more important than the former than the latter
2, 4, 6, 8	Represents the intermediate value of the above two adjacent levels
reciprocal	Indicates the importance of comparing the exchange order of the corresponding two factors

(2) Determine the eigenvectors and maximum eigenvalues of indicator weights

Before calculating the weights, the eigenvector and the maximum eigenvalue are first required. First multiply the elements of each row of the judgment matrix one by one. The product is M_i .

$$M_i = \prod_{j=1}^n \alpha_{ij}, i = 1, 2, \dots, n$$

Open the product to the nth power:

$$\bar{W}_i = \sqrt[n]{M_i}$$

For the resulting vector:

$$\bar{W} = [\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n]^T$$

Perform normalization:

$$\bar{W} = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j}$$

$W = [W_1, W_2, \dots, W_n]^T$ It is a feature vector of indicator weights. From this, calculate the maximum eigenvalue:

$$\lambda_{\max} = \sum_{i=1}^n \frac{(AW)_i}{nW_i}$$

Consistency test : After the eigenvectors and the maximum eigenvalues have been calculated, a consistency check is performed on all the judgment matrices to ensure the correctness and validity of the indicator weights. The test is performed by calculating the stochastic consistency ratio CR if the consistency ratio $CR < 0.1$, you can think that the degree of inconsistency of the judgment matrix is within the allowable range, and use its normalized feature vector as the weight vector; if it is not within the allowable range, the comparison matrix should be reconstructed until it has satisfactory consistency. The CR calculation formula is: $CR = CI/RI$, where RI is the average random consistency indicator and can be found from Table 3 based on the value of the matrix order n. CI is the consistency index and the formula is as follows:

$$CI = (\lambda_{\max} - n) / (n - 1)$$

Table 3 Values of Random Uniformity Indicator RI

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

(No.3) Processing and standardization of indicators

In the evaluation index system of internet financial risk constructed in this paper, there are both qualitative indicators and quantitative indicators. In order to avoid deviations caused by subjective judgments and improve the accuracy of the indicators, the ratio method is used to determine the degree of membership of each single factor. Through the expert scoring statistics, the ratio of the number of people who choose a certain level of the *i*th index to the total number of people participating in the evaluation is taken as the degree of membership of the indicator. The determination method is as follows: There are H-level appraisers to evaluate, and there are m elements in the evaluation factors, and the evaluation results of the appraisers k on the evaluation object i are:

$$U_{i1}^k, U_{i2}^k, U_{i3}^k, U_{i4}^k, U_{i5}^k$$

Only one of the five results is 1, and the rest of the components are 0. Calculate:

$$r_{ij} = \sum_{k=1}^H U_{ij}^k / H, (i = 1, 2, \dots, m; j = 1, 2, 3, 4, 5)$$

ij represents the evaluation result of the evaluator k on the evaluation object i [1].

(No.4) Determining the set of factors and evaluation set of the fuzzy evaluation model

After constructing the above index system and completing the weight calculation, it is necessary to select a suitable method to evaluate the Internet financial risk. The fuzzy comprehensive evaluation method is a comprehensive evaluation method based on fuzzy mathematical theory, which is based on the The theory of subordination changes the usual qualitative assessment into a quantitative assessment, that is, using fuzzy mathematics to make an overall assessment of things or objects that are subject to various factors, with clear results, strong system characteristics, and a better solution to the problem. Difficult to quantify the problem [2]. Due to the ambiguous nature of Internet

financial risks, and considering all factors, fuzzy comprehensive assessment method should be selected for evaluation. The first is to determine its set of factors and assessment set.

(1) Determine the set of factors

According to the internet financial risk assessment system, it can be concluded that the set of factors at the criterion level is: U (operating risk, technical risk, credit risk, business operation risk, legal regulatory risk, other risks) = {U₁, U₂, ..., U_i}, where i = 1, 2, 3, 4, 5, 6.

(2) Determine the assessment set

According to the actual situation of internet financial risk assessment, the comment set is set to 5 levels, namely V = {V₁, V₂, V₃, V₄, V₅} = {high, high, medium, low, Very low}.

(No.5) Establish fuzzy comprehensive evaluation matrix

According to the internet financial risk assessment system and the steps of the fuzzy comprehensive assessment method, the assessment of Internet financial risks requires that the relevant data of internet financial risk indicators be collected first, and questionnaires or expert interviews are generally used. Data collection targets the Internet. Industry management personnel, technical personnel, financial institution employees, experts and scholars, and general users. Once the risk indicator data is successfully collected, the evaluation results can be summarized according to the above calculation method to obtain a fuzzy comprehensive evaluation matrix.

Find the membership matrix:

$$R_i = \{r_{i1}, r_{i2}, \dots, r_{im}\}$$

Among them, R_i refers to the degree of membership of the ith index in the evaluation factor set for each V₁, V₂, V₃, V₄, and V₅ in the comment set. The single-factor assessment matrix for establishing an internet financial risk assessment is shown below.

$$R_1 = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25} \\ r_{31} & r_{32} & r_{33} & r_{34} & r_{35} \\ r_{41} & r_{42} & r_{43} & r_{44} & r_{45} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \\ r_{61} & r_{62} & r_{63} & r_{64} & r_{65} \end{bmatrix}$$

(No.6) Fuzzy comprehensive assessment

After the fuzzy comprehensive evaluation matrix is obtained, a comprehensive assessment of internet financial risks can be made.

(1) Comprehensive analysis and evaluation

Based on the above results, a complex operation is performed on the matrix: B_i = W_i × R_i, and B_i is normalized to obtain a fuzzy comprehensive evaluation vector B₁, B₂, B₃, B₄, B₅, B₆. Then based on the calculation results of the internet financial risk indicator set, establish a fuzzy evaluation matrix:

$$R = (B_1, B_2, B_3, B_4, B_5, B_6)^T$$

Finally, the evaluation vector is calculated according to the formula:

$$B = W \times R = (b_1, b_2, b_3, b_4, b_5)$$

According to the principle of maximum degree of membership, take:

$$b_j = \max(b_1, b_2, b_3, b_4, b_5)$$

The comprehensive evaluation result is b_j .

(2) Calculate the comprehensive evaluation value to obtain the evaluation result

Using the formula $E = B \times C$, the final scores of all levels of indicators of the Internet financial risk assessment are calculated according to the rating standard of the set of reviews: E (Internet Finance Risk), E1 (Operational Risk), E2 (Technology Risk), E3 (E3) Credit Risk), E4 (Operational Risk), E5 (Legal Regulatory Risk), E6 (Other Risks).

VI. ENHANCE COUNTERMEASURES AGAINST INTERNET FINANCIAL RISKS

Although Internet finance has developed rapidly, how to better assess and monitor risks is the lifeblood of its development. In order to promote the healthy, scientific, and orderly development of Internet finance, we hereby propose the following countermeasures for the prevention of Internet financial risks:

- (1) Create an internet financial knowledge system
- (2) Building an Internet Financial Network Security System
- (3) Establishing an internet financial credit risk management system
- (4) Establish and improve the internet financial operation risk management system
- (5) Greatly improve the internet financial supervision and legal system

VII. CONCLUSION

As a product of the development of a new generation of information technology and traditional financial industry, Internet finance has, to a certain extent, become the fundamental force driving the reform and innovation of the financial industry. As a new thing, the problems arising from the rapid rise of internet finance are complex, among which the assessment and monitoring of risks are of the highest priority. Related theoretical research has lagged far behind the needs of practice development. Risk is the essential attribute of internet finance, and it is precisely because of the existence of risk that makes internet finance more attractive. Research on Internet financial risks is a complex and large system that requires long-term and in-depth exploration. It can be affirmed that only a more comprehensive, in-depth and systematic understanding and monitoring of risks can make the development of Internet finance more secure, more dynamic, and more promising.

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