The Application of Fuzzy AHP on the Risk Prevention of Internet Finance in China

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Abstract
Internet finance is the combination of finance and internet technology, which makes people can deal with financial problem and enjoy financial service through network without going out. However, we are facing unprecedented Internet financial risk when enjoy the convenience brought by Internet finance. This paper proposes a framework based on fuzzy analytical hierarchy process (AHP) and fuzzy technique for order performance to identify and rank the risks of Internet finance. The empirical case study analysis of Internet finance is conducted to illustrate the use of the proposed framework. This study classified risk factors and analyzed which factors should be primarily considered. Based on the analysis, we find that Internet financial risk is at a high level. During all the factors, the supervision and competition are the leading factors. A detailed analysis of Internet financial risk is done. Finally, we put forward some advices for defending Internet financial risk from multiple perspectives, such as technology and management level.

Keywords: Internet finance, risk management, AHP, fuzzy mathematics, risk prevention

INTRODUCTION
The rapid development of information network technology has a profound impact on the financial industry. It makes the virtual Internet finance a reality, and promote the emergence and development of financial business activities. From the beginning of 1990s, the traditional financial sector had start to change into the Internet financial industry. With stronger and stronger network technology as well as more and more internet financial service providers, it is an inevitable trend of financial innovation for traditional finance business transferring into Internet finance. The combination of Internet and traditional finance industry make it possible for people to deal with financial activities and enjoy finance service without going out. However, when Internet finance bring us a series of convenience, it is facing not only the risk faced by traditional finance, but also some unique risks caused by its special characteristics. How to guard these potential financial risk is important for the effective measure and previous prevention of Internet financial risk. So, we should master the current situation of Internet finance and analysis the component factors of financial risks. To prioritize the risks of Internet finance is a multi-criteria decision making problem. Human judgment in decision making has been often unclear and hard to estimate by exact numerical values. Hence, fuzzy logic is necessary for handling problems characterized by vagueness and imprecision. This paper proposes hybrid fuzzy Analytical hierarchy process (AHP) and fuzzy technique for order performance. We utilizes fuzzy AHP to determine importance weights of the risks faced by Internet finance. Lastly, an empirical case study is presented to identify the dominant factor using fuzzy evaluation method if we want to perfect management mechanism and improve risk prevention. Based on the summary of corresponding Internet financial risk management research, we find that Chinese researches are mainly around AHP (ANP) AHP, and using fuzzy mathematics to determine the appropriate authority when determine the risk level, then make judgment of Internet finance risk. The western study are started from customer mostly, they focus on the specific measures about risk management in terms of customer’s perceived risk.

After comparing between domestic and foreign Internet finance risk management, we find the shortcoming of domestic risk management, we develop a profound research about how to strengthen domestic internet finance risk management. First, this study attempts to identify the key factors of Internet financial risk management, which is the core and key elements of the study. With the full learning of prior research results, we extract seven key factors affecting Internet financial risk management. Five of the seven factors in the paper are taken from others, and the remaining two are summarized on my own. After the survey, sample collection and collation, using correlation analysis methods, the issues raised by this study has been solved.

This paper proposes a framework based on fuzzy analytical hierarchy process (AHP) and fuzzy technique for order performance to identify and rank the risks of Internet finance (Sachin and Ravi, 2014).
This research prioritizes the factors that should be considered for Internet financial risk management from multiple dimensions base on Internet technology and financial business. Both theory and practice have proved that the method can evaluate Internet financial risk scientifically and provides technical support for financial risk prevention, which is full of theory and practical significance. Similar studies have not been reported.

**.LITERATURE REVIEW**

As we all know, Internet finance is still in the nascent stage of development currently. Seldom research consider it as a whole. Previous studies have focused on the risk management of one pattern of Internet finance, such as mobile payments and peer-to-peer lending, which can give us some reference value.

Internet finance is the third way to conduct financial activities on the basis of indirect financing via commercial banks and direct financing through security markets. From the perspective of financing model, Internet finance is a direct financing model in nature. However, compared with the traditional model of direct financing, Internet finance model has some features such as huge amount and low transaction costs and high efficiency (Xie Ping and Zou Chuanwei, 2012). According to Long Haiyan (2009), the risks faced by electronic banks include internal risks and external risks. Internal risks include the fraud risk caused by internal staff and internal risk management and monitoring improper; external risks, include the risk caused by external fraud. The authors use fuzzy comprehensive evaluation method for internal and external risks assessment and put forward the corresponding control measures on the risk prevention. Zhu Fengping (2010) constructed a risk evaluation system of China Construction Bank and evaluated the weights of risk. The risk indicators were designed from the technical and operational aspect, including 8 first class indicators and 29 second class indicators. The weight of each indicator was calculated through AHP method. Gan Xiaobing, Tao Dajun (2012) used time series characteristics of electronic banking risk data, combined with advantages of wavelet transform decomposing time series, constructed a model of wavelet change law to predict electronic risk. Demonstrated the validity of the model through business examples and draw a conclusion that the risks of electronic banking are closely related to electronic banking transactions. Li Xinyi, Chen Xiaojian (2010) pointed out that compared with traditional banking, Internet finance has a strong network externalities, including the positive and negative aspects. Positive externalities mainly refers that the network can provide financial information sharing, service sharing and profit sharing, negative externalities mainly refers that rapid amplification effect of risk the network has.

Most of the western study are started from customer, they have focused on the specific measures about risk management in terms of customer’s perceived risk. Mather (2008) studied intelligence assessment model of e-banking security based on Fuzzy Logic, and pointed out that Internet-based direct attack would make a greater risk of electronic banking. LEE (2009) divided the perceived risk into five categories: executive, financial, time, social and security/privacy risks, while integrating TAM and TPB model, built a comprehensive model to explain the adoption behavior of the e-bank consumer. The establishment of the adoption of a electronic banking; hakank (2008) proposed a advanced TAM model which was composed of reaction perception, perception interest, perceived behavioral control. It is found that perceived ease and use has a direct impact on consumers’ choice of electronic banking by PLS analysis and that perceived use perceived risk and the attitude toward using electronic banking play a major role in whether accepting electronic banking.

As can be seen from the above literature, research mainly focused on the key factors of Internet finance risk management capabilities is few. Most of them has focused on the decomposition of Internet financial risk through AHP analysis, which can get the appropriate risk weights and give advice about how to guard against Internet financial risk. We will present an in-depth analysis of Internet finance based on the previous studies.

**The Internet Financial Risk Management**

**Definitions of the Internet financial risk**

As Internet Finance is concerned, there is no unified concept. Currently there are many point of view in the industry, some scholars believe that Internet finance is the kind of finance using Internet technology and make financial services more efficient and effective. Some scholars think that the Internet finance is different from traditional finance. It is a financial revolution. Baidu Encyclopedia definition of Internet finance is: the emerging field where the traditional finance industry is combined with internet spirit. The spirit of "openness, equality, cooperation, sharing," are penetrating into the traditional financial format, resulting in a fundamental impact on human financial model. The financial model with Internet spirit is called as Internet finance. These definition are generated when they areas and different purposes (Liu Liang, 2013).

In summary, we think that Internet finance is a new financial service channel for customers deal with financial business through a variety of self-service access equipment on their own, using the computer financial technology and network communication technology. In a broad sense, Internet finance include but are not limited to third-party payment, online sales of financial products, credit evaluation.
Financial risk refers to the loss caused by the divergence of commodity prices, financial asset prices, interest rates, exchange rates deviate from the expected value when we conduct financial activities during a certain period of time. Financial risk is due to the uncertainty of financial activities, which will cause loss to investors. Internet financial risks have their own characteristics on the basis of traditional financial risks. Two aspects can be summed up as follows: one is business risk based on traditional financial services, the second is technological risk based on online listings. There are security risks and technical risk from network platform. The business risks are mainly including operating risks, market selection risk, reputation risk and legal risk.

3.3 Identification and assessment of domestic Internet financial risk

The basic premise of Internet financial risk management is to identify the risk accurately and timely, which is a severe challenge for risk management. Internet finance business is virtual and complex, so it is difficult to identify those risks. Each identification mistake would result in huge risk loss. Currently, we usually identify those risks by constructing a risk list. All risks maybe faced by Internet finance are listed on the table. In order to determine the identification method, we will contact relevant parties to make a risk analysis deeply.

Ambiguity and its Impact on Internet Financial Risks

Ambiguity is the phenomenon that the result of things is single and certain, while the result is not clear. Uncertainty is the phenomenon that the result is clear, while it is uncertain which result will happen during many results. Widespread uncertainty and ambiguity will lead to Internet financial risks, so providers and users of financial information should regard significant impact of potential risks on our decision-making objectively (Xu Jing, 2011). AHP is a structured technique for organizing and analyzing complex decisions based on paired comparisons of both projects and criteria (Satty, 1986).

Risk Identification and Ambiguity of Authorization

According to different type of loan object and asset, we divide the basic risk weight into several levels, that is 0, 10%, 20%, 50% and 100%, so we can know the content of various types of assets. We consider it as basic standard to identify those risks, in other words, we classify economic matters into different type from space, time and morphological aspects. However, classification is accompanied by the generation of ambiguity. In most cases, it's rely on the subjective experience of the person concerned.

Large Ambiguity of the Actual Operation

As the credit rating risk weights and asset shape risk weights are determined by the Internet financial enterprises on their own, subjective judgment becomes important factors to identify risk. Western Empirical studies show that there are a lot of factors that affect the subjective judgment, such as different occupations, individuals and groups, personality, etc. These factors alone or intertwined will affect the identification and recognition of risk to different extent and may result in inaccurate information.

Ambiguity of the Analysis and Evaluation Methods

People often make several assumption and premise when they try to describe things accurately through mathematics method, which is full of ambiguity. For example, the efficient market theory is premised on the capital asset pricing model, which requires several assumptions, and the model determining $\beta$ coefficient is also subjective. In addition, the disclosure of accounting information to the same type of economic matters will be different because of different subjective judgments, such as the disclosure of lawsuit on accounting statements.

RESEARCH FRAMEWORK

Under the premise of using fuzzy comprehensive evaluation method and AHP, we evaluate the risk from multi-layer and call this method fuzzy mathematics evaluation method of Internet financial risk. We develop a comprehensive assessment of the risk perhaps faced by Internet finance through this method, so the result can be more objective and accurate relatively (Xiong Wenqiang and Yin Gang, 2012). The process of our study went through three stages for assessing the Internet financial risk, involving (1) formulating a hierarchy model containing the assessment criteria, and factors; (2) refining the measures of criteria and factors using the expert scoring method; (3) identifying the weights of criteria and factors through fuzzy AHP.

Method for Determining Membership of Risk Indicators

Because the source of qualitative and quantitative background data is different, the determining method should also be different when we use fuzzy AHP method.

Membership of quantitative indicators are determined by the linear scoring method, this method is one of the fuzzy distribution function. They have many
forms. And in general, we say its optimal value is "x\(^ r \)" and identified it as 100 points, while the worst value is called "x\(^ b \)" we can determine the worst value is 0 point, and establish a linear scoring function, that is:

\[
Y = \frac{(X-x^b)}{(x^r-x^b)}
\]

In addition, there is improved linear scoring function \[^{[1]}\]:

\[
Y = \begin{cases} 
1 & 0 \leq X \leq a_1 \\
\frac{a_2-X}{a_2-a_1} & a_1 < X < a_2 \\
0 & X \geq a_2
\end{cases}
\]

In the male party: \( a_1, a_2 \) is the upper bound and lower bound of the scoring function respectively, that is to say, \( a_1 \) is the maximum value, \( a_2 \) is the minimum value, selection of the value has important impact on determining the value of scoring function. To solve this problem, we need to take specific practical work into consideration. Especially, we should reconsider Internet financial risk indicators and make a prudent decision.

For the membership of qualitative indicators, we use expert scoring method. Firstly, the experts don't need to evaluate the objects by identified values, that is, they can mark the objects in a range by 1-9 sign method. After statistics, analysis and generalization, we can get a more reasonable estimation on the basis of most expert’s experience and objective judgment.

The Fuzzy Mathematic Evaluation Model

In summary, it is extremely important to identify risk factors of Internet finance. While, the most important task is to establish a "fuzzy comprehensive evaluation model", as shown in the following steps: Let \( U = \{U_1, U_2, U_3 \ldots U_m\} \) be a goal set that represents the elements of the evaluation factors. Each object is then analyzed for each goal respectively. Therefore, m extent analysis values for each object are attained:

The Evaluation set V:

\[ V = \{V_1, V_2, V_3, V_4, V_5\} = \{\text{Higher risk, high risk, medium risk, low risk, lower risk}\} \]

Here, we set R as the overall rating matrix which is composed of n program, while each program is the combination of m indicators:

\[ R = (r_{ij})_{mn} \]

namely:

\[
R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\
r_{21} & r_{22} & \cdots & r_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}
\]

\[ R_i = (r_{i1}, r_{i2}, \ldots, r_{in}) \quad (i = 1, 2, 3, \ldots, m) \]

is the fuzzy evaluation set of single factor in \( U_i \), the fuzzy set is a subset of V. \( r_{ij} \) is the degree of membership \( V_j \) of \( U_i \) \((j = 1, 2, 3, 4, 5)\)

Where in the weight set \( A = \{a_1, a_2, \ldots, a_m\} \). And there: \[\sum_{i=1}^{m} a_i = 1\].

Fuzzy subset of the index set U, the fuzzy subsets corresponding to the degree of importance of various types of lines were reflected in the index system. Is the weight. And shall comply with the normalization requirements.

B is evaluated on a set of fuzzy subsets V, then:

\[ B = \begin{bmatrix} F_{11} & F_{12} & \cdots & F_{1n} \\
F_{21} & F_{22} & \cdots & F_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
F_{m1} & F_{m2} & \cdots & F_{mn} \end{bmatrix} \]

Where:

\[ A: \text{weight vector, } A = \{a_1, a_2, \ldots, a_m\}. \]

The first. The overall objective evaluation indexes is to get the total weight value \((\text{Between } i = 1, 2, \ldots, m)\)

\[ R: \text{n is a solution, and each solution is a combination of the m total evaluation index} \]

evaluation matrix \( R = (r_{ij})_{mn} \):

\[ r_{ij} \] is the membership of elements for \( j^{th} \) Index membership. \( r_{ij} \in [0,1] \), and

has: \[\sum_{j=1}^{m} a_i = 1\]:

\[ B: \text{Comprehensive evaluation matrix, } B = [b_1, b_2, \ldots, b_n] \]

\[ b_j \] : For a comprehensive evaluation of the j program, in which the b value if the larger, then it indicates that the higher the risk of Internet banking,
and Minimum program indicates that the program is minimal risk, which is the optimal solution.

\[ b_j = \sum_{i=1}^{m} a_{i,j} \quad (J = 1,2, \ldots, n) \]

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The Establishment of a Multi-Level Fuzzy Comprehensive Evaluation Model

Based on the analysis of Internet financial risk factors, we build an internet financial risk evaluation index system as shown in Figure 1:

In order to further carry out fuzzy evaluation, we need to evaluate the weights of each indicator. Then, we can use the fuzzy AHP on the basis of evaluating indicators. Therefore, it is necessary for us to build the fuzzy analytic hierarchy model. In addition, the model should be established according to the affiliation between each index. To structure FAHP model, we first constitute a hierarchical structure into three level

The survey of professionals and non-professionals show that if X is a set of factors affecting Internet financial risk:

\[ X = (\text{financial environment, economic nature, competition, regulatory authorities regulators, financial status of financial institutions, technical capability, network security, technology selection}) = (X_1, X_2, X_3, X_4, X_5, X_6, X_7) \]

Note:
(a) Financial environment \( X_1 \): the national macro-control policies, changes in the international economic environment, changes in macroeconomic and financial policies, interest rates, exchange rates, the central bank refinancing, changes in the discount rate, etc.
(b) Nature of Business X_2: e-money, online banking, online payment, online securities and insurance
(c) Competition with X_3: an increase in the number of Internet-based financial institution, the interest rate market, diversification of types of services
(d) Regulatory authorities X_4: soundness oversight bodies, management quality, and other internal situation
(e) Financial institutions on its financial position X_5: Earnings good general level, level of losses.
(f) Network security X_6: Internet banking is built on the basis of knowledge of computer networks, hidden by a defect network technology posed.
(g) Technology Select X_7: conduct financial business Internet must select a technology solution to support, so there is a risk technology selection errors.

In this paper, we compare two indicators of the same level through expert opinions method (He Dewen and Huang Zhendi, 2013). We calculate the relative weight of each index after constructing judgment matrix, and then, we get the corresponding weights of risk indicators after normalization and consistency test. In this paper, due to space limitations, specific data and processes are limited. We display the final result directly. The relative weight of each index value:

\[ A = (0.15, 0.1, 0.1, 0.2, 0.2, 0.15, 0.1) \]

Because ambiguity of risk levels, it is ambiguous for each index belonging to a specific level is. In this article, the risk will be divided into five levels, namely lower risk (negligible risk), low risk (acceptable risk), moderate risk (edge risk), the higher risk (worth alert, unacceptable risk), high risk (disaster risk serious damage to the system). It further set of five levels in each range of possible indicators such as points, which is equal to the length of each grade range, denoted h, easy to get, h interval length as the index value of 1/5. Available,

\[ V = \{V_1, V_2, V_3, V_4, V_5\} = \{\text{high-risk, high risk, medium risk, low risk, low risk}\} = \{1, 0.8, 0.6, 0.4, 0.2\} \]

126 questionnaires are distributed to Internet financial professional, 103 valid questionnaires are returned. The respondents comprised 89 males and 14 females; approximately 64% of respondents had more than 10 years of work experience in financial risk management (Jaemin Cho and Jaeho Lee, 2013). They were asked to make a pair wise comparison judgment and give the relative importance among the risk management criteria and factors. The pair wise judgment is conducted from the first level to the fifth level. Industry practitioners or experts individually expressed their preference between each pair of elements. Scoring for seven indicators in the financial environment, nature of business, with the evaluation of the attitude of a percentage of all persons involved in the evaluation of the total number represented get fuzzy evaluation matrix.

Weights of Evaluation Index

\[
R = \begin{bmatrix}
0.4 & 0.3 & 0.2 & 0.1 & 0 \\
0 & 0.2 & 0.6 & 0.2 & 0 \\
0.2 & 0.4 & 0.2 & 0.1 & 0.1 \\
0.5 & 0.2 & 0.2 & 0.1 & 0 \\
0.5 & 0.2 & 0.1 & 0.1 & 0 \\
0.6 & 0.2 & 0.1 & 0.1 & 0.1 \\
0.2 & 0.3 & 0.2 & 0.1 & 0.1
\end{bmatrix}
\]
according to the principle of maximum membership degree, take 

\[
\max \{b_i\} = (0.39, 0.245, 0.225, 0.12, 0.02)
\]

Corresponding to the level indicator corresponding evaluation results can be obtained as a result of \(b_1 = 0.39\), corresponding which corresponds to the level is high risk. In our model, the Internet financial risk is at a high level (Zhang Yunxia, 2012).

CONCLUSIONS AND SUGGESTIONS

Through solving the research model, we can see that the Internet finance are in high risk and this situation is rather serious. Thus it is very urgent to know how to alleviate the Internet financial risk problem. It can be inferred from the above analysis that we can analyze the factors causing the Internet financial risks by using the fuzzy mathematics method. According to the empirical results, we put forward the suggestions as follows

(1) The comprehensive evaluation method of fuzzy mathematics can be applied to the formulation of Internet finance accounting system, which is conformed to the “substance over form” view. Recently, various countries’ accounting standard-setting boards began to realize the scientific nature of the fuzzy method. For example, SEC considers that “importance” can’t take 3%-5% as standard, instead there should be a qualitative instructions.

(2) The construction of Internet financial system should be strengthened.

Our country has started late in the development of information technology. At present, our country’s computer hardware and software systems mostly come from the relative outdated products, which to a large extent has a bad impact on the Internet financial risk prevention (Hakan, 2008). Thus, we should pay great attention to the development of information technology and accelerate the developing process of information industry in our country. We should develop the advanced information technology with proprietary intellectual property rights so as to strengthen the construction of Internet financial system and improve key technology of computer systems and the security defense capability of computer hardware and software systems (Xu Jing, 2011). Only by doing it can we prevent and reduce the Internet financial security risk and technology selecting and supporting risks.

(3) The construction of legal systems for preventing and controlling the Internet financial risk system should be strengthened.

At present, our country’s banking law, securities law and insurance law are based on traditional finance, which may not be adaptable to the development of Internet finance. They make the rights and obligations among trading main bodies unclear, which is not good for further development of Internet finance market. So, we should improve the laws and regulations for preventing Internet financial risks and the regulations about market access, capital flow and quit. The Internet financial transactions regulatory system with unified standards should be established. At the same time, by referring to foreign Internet financial legislation, we can improve the rules such as consumer privacy protection, the legitimacy of electronic contracts and the confirmation of trading evidence and so on. Finally, we can establish the Internet financial market with clear responsibilities and legislations.

The development of Internet finance provides people with convenient and fast financial services, but also causes unprecedented Internet financial risks. The existence of these risks greatly influence the security of transaction and fund and the healthy development of finance. Thus, it is very necessary to prevent Internet financial risks in order to ensure Internet finance’s positive role on economy.

The limitation of this paper is that the type of risks in the Internet finance is various and complicated , whose type and characteristics is difficult to forecast .Besides, Internet finance will change with the Internet quickly , the risk we take into consideration today maybe not the leading factors in the future

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