The Game Strategy of Sustainable Development of P2P Internet Loan

Zhong Ling

Abstract— **P2P network lending is a new type of Internet finance model for individuals and small and micro enterprises borrowing money. It is different from traditional bank lending and has the characteristics of high flexibility and ease of application. The phenomenon of default and fraudulent operation of P2P online loans in actual financial activities has aroused great concern from the society and the government. For the sustainable development of the emerging Internet financial model, this article based on the P2P network loan model, introduced the asset breach protection measures—insurance system, P2P platform registered margin system, government central bank supervision system, and established a mathematical model to obtain the optimal game strategy.**

Index Terms— **P2P network loan; margin; insurance system; game strategy.**

I. INTRODUCTION

In the Internet finance model, Peer-to-Peer Lending (P2P) is a new type of financial transaction model, which is different from traditional bank lending. It collects very small amounts of funds and lends it to a business model with funding needs. . In the process of lending, information, funds, contracts, procedures, etc. can all be realized through the Internet. It is a financial model developed with the development of the Internet and the rise of private lending, and it is also the development trend of future financial services.

The idea of creating a foreign P2P online loan is to allow through a third-party online loan platform. Representatives of the third-party online loan platform include the United Kingdom Zopa and the United States Prosper. The first global P2P online loan platform, Zopa, co-created by four British youths such as Richard Dewar in March 2005, the lenders listed the amount, interest rate and time they wanted to lend on the online loan platform. The borrower of the funds compares the various "products" of the loans and determines the plans that suit them. The lenders have different requirements for the credit ratings of the borrowers with different interest rates. The company proposes a diversified investment model in order to reduce the risk of default, and establishes a legally binding contract between the borrower and the borrower. At the same time, Prosper established the largest online lending platform in the United States in February 2006. It uses the input borrower's demand line of funds to automatically match the lenders to form different interest rate combinations. The lender bids for the company's own credit rating. And finally won the bid to borrow "products." As foreign P2P online lending platforms are established early and the system is relatively complete, fund lenders can obtain more returns

through Prosper or Zopa, and are widely accepted by the general public.

The earliest first online lending platform in China was ppdai, which was established in August 2007. The pat loan modeled on Prosper's model. Borrowers set their own borrowing interest rate through the guideline interest rates of different credit ratings published on the website. The lender comprehensively judges the degree of risk of the borrower based on the credit rating of the borrower and the data uploaded by the lender, and then decides whether to lend a part of his own money to the borrower. The website will do a final fraud detection review. For those who are suspected of fraud, the website will reject the loan transaction for the purpose of protecting the lender. In recent years, China's traditional economic model has been affected by the world economy and has undergone tremendous changes. The Chinese lending market has changed from the traditional traditional bank lending model to a market-based lending model in which the internet financial lending and traditional bank lending models are concurrent. The P2P online lending platform is booming, with an average speed of 1-2 homes per day. The phenomenon of imbalances in supply and demand of funds brought about by a large increase in the number of platforms has begun to appear gradually.

This article mainly analyzes the phenomenon of default and fraudulent operation of P2P online loans in actual financial activities, integrates with China's national conditions, and introduces the assets breach protection measures—insurance system, P2P platform registration margin system, and government for the sustainable development of the emerging Internet financial model. The central bank supervision system establishes a mathematical model to find the optimal game strategy.

In the development of P2P online lending, foreign development started earlier. With the promotion of China's Internet finance under the national policy, P2P loans have mushroomed, and there have been many risks of breach of contract and fraud in actual economic activities. Gao Ruiqiong [1] and others have outlined the status of P2P lending research. Martina Pokorná [2] studied the social loans and risks under the financial system of the Czech Republic, and put forward credit risk assessments to make risk prediction and risk elimination recommendations for individuals, platforms, and banks, respectively. Li Xue [3] and others discussed the P2P risk and risk control in the Chinese lending market; Yan Hong Guo [4] and others studied the risk assessment of an instance-based P2P lending decision and proposed a unilateral review of the borrower's credit level. To lend funds to lenders to invest in decentralized funds to enjoy the combined interest rate and reduce the risk of default. Prosper is a real-life lending finance that uses this method to manage risks; Yu Lin, Kang Canhua [5] and others

Zhongling, College of Mathematics and Statistics, Northwest Normal University,Lanzhou,China,86-15294177220

studied the regulatory application of game knowledge in the P2P network loan model, and proposed new concepts such as the unified credit rating system, the introduction of insurance system, the encouragement of regulatory innovation, and the establishment of a market withdrawal system; Li Haifeng et al. [6] used statistical knowledge to conduct abnormal point detection methods in P2P lending credit data, and had an innovative study on managing and controlling lending risk. Cao Hui [7] used dynamic Bayesian game attack prediction model to predict attacker behavior. This paper puts forward the P2P platform registration margin system put forward in the previous research. At the same time, it introduces the game strategy under the insurance system and the simultaneous supervision system of the government central bank, and puts forward suggestions for optimizing the P2P online loan system.

II. MODEL I

2.1 P2P platform registration margin system

In the practice of P2P platform online lending in China, it is not difficult to find that some P2P platforms borrow money to falsely report the borrower's actual credit or fabricate false borrower information, causing lenders to lend funds to sub-optimal borrowers or P2P platform fraud lenders. The funds form the hardest-hit areas for defaults and frauds in Internet finance. Among them, the main reasons for the emergence of patronage and fraud incidents on the P2P platform are: the lack of supervision of intermediate capital accounts, and the P2P platform has the right to redeploy funds from intermediate accounts. This phenomenon is mainly due to the government's lack of review of third-party lending qualifications, and its borrowing qualifications are mainly reflected in the platform's economic strength in the deposit limit setting and other aspects of the margin.

2.2 The basic assumptions of the P2P online loan platform registration margin system

Prerequisites for the P2P online lending platform's registered margin system: If more than 40% of the default rate occurs in the supervision process, the margin needs to be repaid. If the deposit can not be repaid, the operation will be forcibly suspended, and the forfeited deposit will be used for compensatory repayment. The audit is conducted semi-annually. If the default rate of the transaction data after the company audit is less than 8%, the government will give a margin of 0.3%. The rigorous review of the P2P online lending platform has made both lenders and borrowers trust the platform. With good reputation effects, potential customers (mostly risk-averse) tend to choose reputable platforms for lending.

P2P online loan platform registration margin system parameter settings: M_1 on behalf of the company guarantees a high degree of money, M_2 on behalf of the company guarantees a low degree of money （$M_1 \gg M_2$）; t_1 represents the government tax revenue when the P2P platform auditing is strict, t_2 on the P2P platform is not strictly audited tax （$t_1 > t_2$）; P stands for P2P platform auditing profit; φ% stands for default rate under government supervision. When φ% ≤ 8%, it means that P2P lending platform audit is strict. When φ% ≥ 8%, it means that P2P lending platform is not audited. Strictly, here specialization

occurs when φ%=40%, the margin repayment or stop operations; here requires the government tax to meet: $\frac{3}{1000}M_1 \leq t_1 - t_2 \leq \frac{1003}{1000}M_2$.

2.3 The Nash Equilibrium of the Game of the P2P Net Loan Platform Registration Margin System

Table 1 game revenue matrix

P2P online loan platform	Government revenue	
	High margin (M_1)	a low margin (M_2)
Strict **φ% < 8%**	$(P + \frac{3M_1}{1000} - t_1, t_1 - \frac{3M_1}{1000})$	$(P + \frac{3M_2}{1000} - t_1, t_1 - \frac{3M_2}{1000})$
Not strict **φ% ≥ 8%**	$(P - M_1 - t_2, t_2)$	$(P - M_2 - t_2, t_2)$

From table 1, it can be found that when $t_1 - \frac{3M_1}{1000} \geq t_2$, the P2P net loan platform and the government are strictly dominated by pure strategy Nash equilibrium, point $(P + \frac{3M_1}{1000} - t_1, t_1 - \frac{3M_1}{1000})$ as pure strategy Nash equilibrium. When $t_1 - \frac{3M_1}{1000} < t_2$, the P2P net loan platform audit strict probability is p, the audit is not strict probability is 1-p; the government chooses to collect high margin probability is q, the probability of collecting low margin is $1 - q$;
When the P2P network loan platform is strictly audited, the expected benefits of the net loan platform are:
$E_1 = q\left(P + \frac{3M_1}{1000} - t_1\right) + (1 - q) \times (P + \frac{3M_2}{1000} - t_1)$;
P2P net loan platform audit is not strict, net loan platform's expected revenue:
$E_2 = q(P - M_1 - t_2) + (1 - q) \times (P - M_2 - t_2)$;
When the government receives a high premium, the government's expected revenue is:

$$E_3 = p\left(t_1 - \frac{3M_1}{1000}\right) + (1 - p) \times t_2$$

When the government receives low margin, the government's expected revenue is:

$$E_4 = p\left(t_1 - \frac{3M_2}{1000}\right) + (1 - p) \times t_2$$

The average income of P2P net loan platform:

$$\overline{U_{P2P}} = pE_1 + (1 - p)E_2$$

The average revenue of the government:

$$\overline{U_G} = qE_3 + (1 - q)E_4$$

Create a copy dynamic equation:

$$\begin{cases} \dot{U}(p) = E_1 - \overline{U_{P2P}} = p(1 - p)(E_1 - E_2); \\ \dot{U}(q) = E_3 - \overline{U_G} = q(1 - q)(E_3 - E_4); \end{cases}$$

obtain $(p_*, q_*) = (0, \frac{t_1 - t_2 - \frac{1003}{1000}M_2}{\frac{1003}{1000}(M_1 - M_2)})$,

As a result, the hybrid strategy can not restrain the P2P net loan platform to reach the condition that the default rate is not less than 8%. The result is that the P2P net loan platform audit is sluggish and does not play a promotion role.

2.4 The analysis of model

In the discussion of the pure strategy and mixed strategy of the P2P net loan platform registration margin system, we give a screening condition for the P2P net loan platform, if the third party lending platform qualification satisfies the constraints: $t_i - \frac{3M_*}{1000} \geq t_*$ and $M_* > t_*$, (t_i represents the tax of the platform in the P2P network loan platform, t_* represents the high level of the industry level. " The average value of tax revenue is good platform, M_* represents the industry level, high reputation, good platform margin average. If the government departments account for the tax, the P2P net loan platform which is in line with this condition is called the growth type third party network loan platform; the government should stop operating the net loan platform which is not in line with this condition. This measure can not only improve the quality of P2P net loan platform in the market and the conditions of entering the market, but also improve the tax of P2P net loan platform within the scope of risk control, which can promote the benign development of the network loan platform.

III. MODEL II

3.1 P2P net loan borrowing strategy game insurance system

In the foreign P2P network loan platform, the American Prosper and Czech Symcredit are divided into seven types of borrowers in strict credit rating. The success rate of the application loan for the level AA is 40%, and the success rate of the application loan with the level of HR is only 4%. At the same time, 0.06% of the applicants at the level of AA still have a default rate, with a 7.50% default rate among the applicants with a level of HR, which is more pronounced in the country. This shows that the high level can only guarantee a small proportion of default. Because of the asymmetry of information between the borrowers and the borrowers, the borrowers may forge credit credit, and the borrowers in reality are risk aversion. So the key to solve the problem is to introduce the insurance system in combination with the national conditions.

In the P2P net loan of China, the information asymmetry between the borrowers and the borrowers may forge the credit degree, resulting in the integrity of the credit system of the P2P network loan platform. The precondition of P2P net loan insurance system:

1) the participants include borrowers, P2P network lending platforms and lenders.

2) the borrowers who have entered the P2P market are divided into two types of good and bad credit, but the information only borrowers themselves know, the others do not know that the good credit difference depends on the rate of reimbursement and the rate of default in the process of credit.

3) borrowers can choose whether to submit materials according to their credit level.

4) P2P net loan platform in the audit, even if the credit degree is good, may not pass the possibility, can use the exception point detection method [8], credit poor borrower in the audit, do not allow access to the market.

5) lenders, whether audited or not, need to continue to choose strategies of insurance and no insurance.

6) introduce the third party nature (Nature) as the starting point of game, and internalization [8] of borrowers' credit process.

3.2 The basic assumptions of P2P net loan insurance system

B is the cost of submitting information to the market by the borrower; C is P2P platform carries out the audit cost of the credit investigation, and then forms a risk identification form for the lender after the audit; M is P2P platform audit income; L is the loss to the P2P platform and lenders brought by the non qualified borrowers after entering the market; W1 is the borrower obtains the income of the loan through the audit; W_3^i : is When $i = G$, the borrower borrows the money to the borrower's expected return W_3^G when the credit is good, and when $i = B$, the borrower borrows the money to the credit margin, the borrower's expected return is W_3^B ($W_3^G < W_3^B$). S_i is when $i = G$, the borrower borrows the money to the credit of the good borrower's insured amount S_G, when $i = B$, the borrower borrows the money to the credit margin of the borrower's insurance amount S_B; λ is ratio of insurance $\lambda = S_i / W_3^i$;Q is the amount of the credit poor borrowers is Q=W_3^B / λ.

3.3 Sub game refining Nash equilibrium of P2P net loan platform insurance system game

The borrower in the choice of the insured to give "history", in turn in the lenders, P2P net loan platform and the borrower every action choice start to the end of the game constitutes a game, called "sub game [10]". The participants' strategies are required to form Nash equilibrium and the Nash equilibrium of the whole game in every sub game, and the equilibrium is called the subgame refined Nash equilibrium. In other words, the strategy of sub game refining Nash equilibrium must be optimal in every sub game, as shown in Figure 1.

In the P2P net loan, we can get the following conclusions based on the benefits of each participant I in the following game tree.Give the basic assumptions:

u_i^j: i is the participant (i=1, 2, 3, respectively, representing borrowers, P2P network lending platforms, lenders). j said the choice of history type h_i^k. When j=1,2,3,4,k=1,$\cdots$,6, h_i^k are divided into $(a_0^1, a_1^1, a_2^1, a_2^5)$, $(a_0^1, a_1^1, a_2^1, a_2^6)$, (a_0^1, a_1^1, a_2^2) , (a_0^2, a_1^3, a_2^3) , (a_0^2, a_1^4, a_2^4) . u_i^j It represents the benefit function of participants i in selecting the first historical period j.

a_i^k: i representative actor.(when i=1，1，2，3，They are natural borrowers, P2P platforms, lenders.) k represents the k action strategy of the actors; a_i^k express the k action strategy of the i actor;

In the P2P net loan, we can get the following conclusions based on the i revenue of each player in the game tree above.
a) the borrower's earnings u_1^j: $u_1^4 = u_1^2 > u_1^1 > u_1^3$;

b) revenue from P2P platformu_2^j: $u_2^3 = u_2^1 > u_2^2 > 0 > u_2^4$;

c) lenders benefitedu_3^j: $u_3^2 > u_3^1 > u_3^3 > u_3^4$;

To sum up, under the two types of good credit and bad credit, borrowers get sub game refined Nash equilibrium under two branches. In the game tree under the system of P2P net loan insurance, it is not difficult to find the way that the borrower chooses uninsured under the favorable borrower's type. When the borrower's type is poor, it is found that the borrower is a huge loss to itself whether or not it is insured, and the P2P net loan platform will refuse to pass through most of the audits. To prevent breach of contract. This conclusion is consistent with the passing rate of borrowers' credit level in foreign P2P lending platform. P2P net loan insurance system neutrons game refining Nash equilibrium is shown in Figure 2.
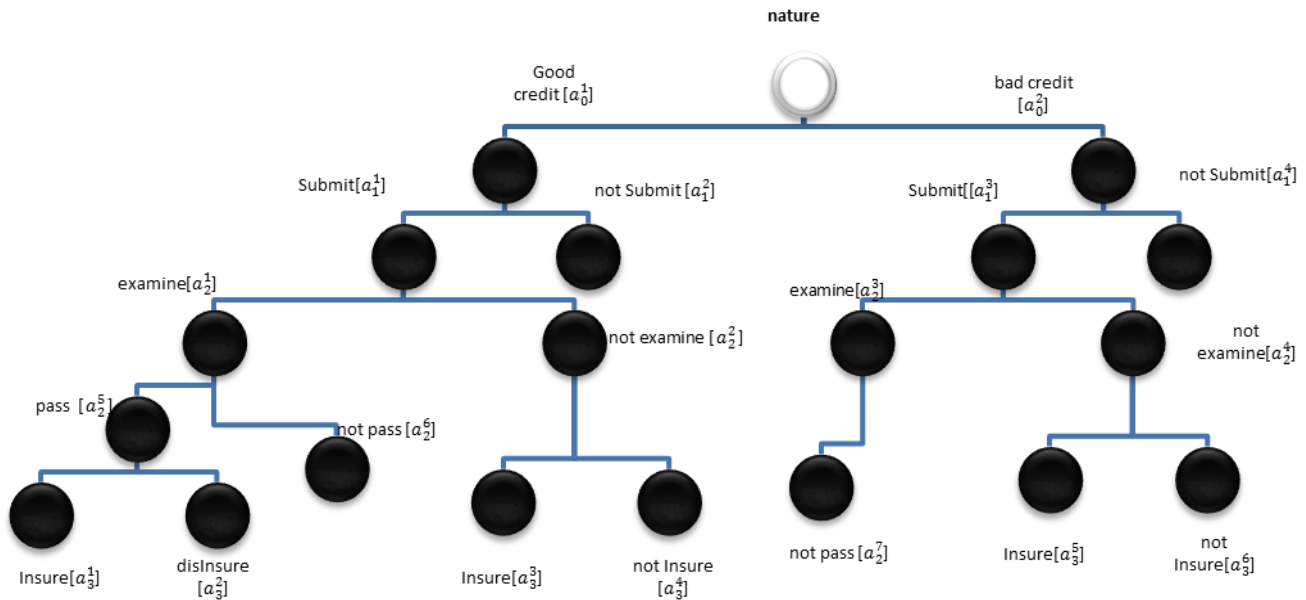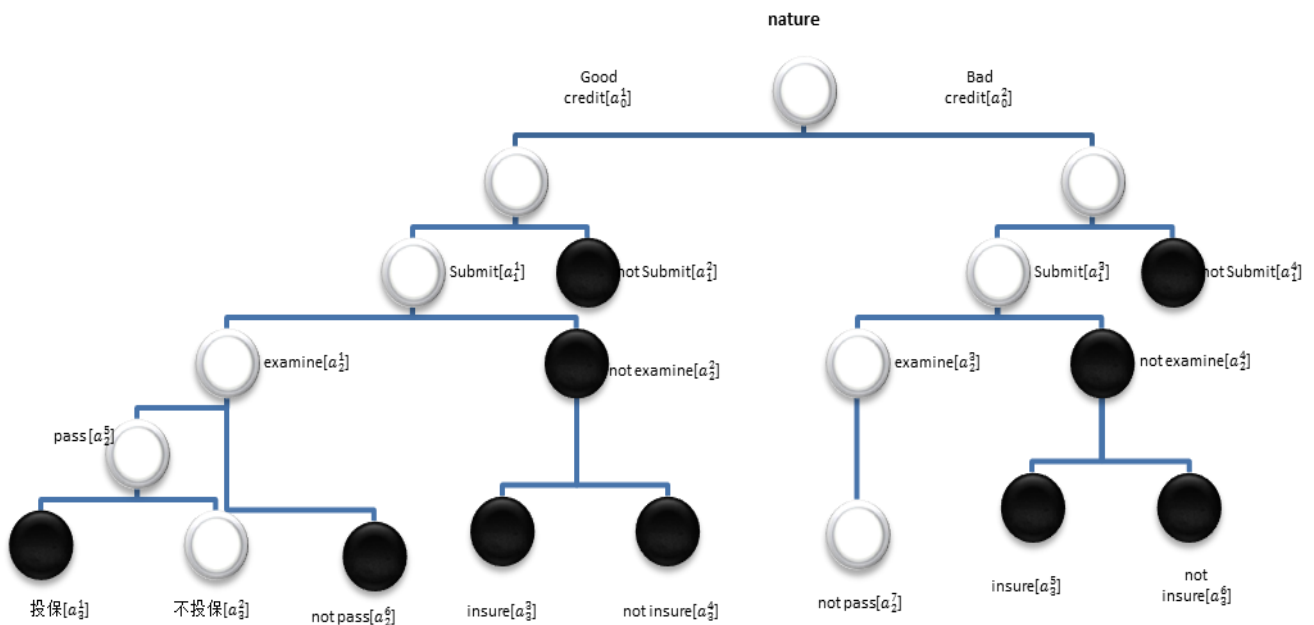

Figure 1 Game tree under insurance system

Figure 2 Neutron game refining Nash equilibrium of P2P net loan insurance system

○ : It indicates the optimal strategy of game tree in natural selection when borrowers are type G or B.

● : It represents sub optimal strategy of game tree in natural selection when borrowers are type G or B.

3.3 P2P net loan insurance system -- multistage incomplete information game

P2P net loan insurance system is a kind of observable and incomplete information multistage game, which has multiple action stages. Definition of natural selection type $\theta_0 = $ (credit good, credit bad), borrower 1 selection type $\theta_1 = $ (Submit, non Submit), P2P net loan platform 2 type $\theta_2 = $ (examine, not examine, pass, non pass), lenders 3 type $\theta_3 = $ (insure, not insured). Assuming that each participant is independent of the type of action at each period, a_i^k represents the k action of the actor i in the game, and $a_i = (a_i^1, a_i^2, \cdots, a_i^k)$ represents all the set of actions of the participant i, and h_i^k represents the history of the participant before the t behavior, such as $h_2^5 = (a_2^1, a_1^1, a_0^1)$. A behavior strategy is defined to map the possible history and type set to the action space: $P(a_i^k|h_i^k, \theta_0)$ is the probability of a_i^k when given h_i^k and θ_0. This paper extends the concept of subgame perfection to a multi stage game. Using Bayesian conditional probability formula, every "follow-up game" after each participant i's possible history h_i^k is not a single information set. In order to transform the "follow-up game" into a game, each participant is set up before the game of i. A Bias Nash equilibrium is generated by putting prior probability (belief in i). In a multistage game, the hypothesis is assumed：

(1) posteriori beliefs are independent of each other, and all types of participants in I have the same beliefs. For θ, t, h_i^k $P(a_i^k|h_i^k, \theta_0) = \prod P(a_i^k, h_i^k|, \theta_0)$;

(2) whenever possible, we use Bayes rule to update belief $P_i(\theta_i|h^t)$ to $P_i(\theta_i|h^{t+1})$: For all i, j, h_i^k and a_i^k; If there is $\hat{\theta}_j$,
bring $P\left(\theta_j\middle|(h_i^k, a^k)\right) = P_i(\theta_i|h_i^k)P(a_i^k|h_i^k, \theta_j)/\sum_{\hat{\theta}_j} P_i(\hat{\theta}_j|h_i^k) P(a_i^k|h_i^k, \hat{\theta}_j)$;

(3) for each participant i and type θ, other strategies of participants i, θ' and historical h_i^k are all satisfied $u_i(\theta|h_i^k, \theta_i, P(\cdot|h_i^k)) \geq u_i(\theta'|h_i^k, \theta_i, P(\cdot|h_i^k))$;

The parameters of multistage game under the P2P net loan insurance system are:

(1) natural selection borrowers' credit types and probability of good borrower $P(G|\theta_0) = p$, credit margin of the borrower's probability $P(B|\theta_0) = 1 - p$ $(0 < p < 1)$;

(2) when the borrower submits credit information to the P2P net loan platform, the probability of the platform's audit is set up when the borrower has good credit $P(a_2^1) = P(a_2^3) = \alpha$. If no audit is recorded as $P(a_2^2) = P(a_2^4) = 1 - \alpha$ $(0 < \alpha < 1)$;

(3) in P2P net loan platform audit, the probability that the borrower can pass the audit is good $P(a_2^5) = \mu$. The probability of not passing the audit $P(a_2^6) = 1 - \mu$ $(0 < \mu < 1)$; If the borrower has a bad credit, he will not pass the probability when he submitted and audited $P(a_2^7) = 1$;

(4) when lenders resist risks, the probability of lenders' insurance is set up $P(a_3^1) = P(a_3^3) = P(a_3^5) = \beta$, the probabilities of the borrower $P(a_3^2) = P(a_3^4) = P(a_3^6) = 1 - \beta$ $(0 < \beta < 1)$;

(5) the probabilities of the borrower when the borrower's credit is good $P(a_3^m|G) = \beta\mu\alpha p + \beta(1 - \alpha)p$ $(m = 1,3)$; The borrower does not cover the probability when the borrower's credit is good $P(a_3^m|G) = [1 + \beta((1 - \mu)\alpha - 1]p$ $(m = 2,4)$； The probability of the borrower's insurance on the borrower's credit margin $P(a_3^5|B) = (1 - p)(1 - \alpha)\beta$；The borrower does not have an insurance probability when the borrower's credit is poor $P(a_3^6, a_2^7|B) = (1 - p)[1 + \beta(\alpha - 1)]$;

Based on multi-stage incomplete information dynamic game, we get posterior probability. A borrower's probability of good credit when selecting insurance $P(G|a_3^m) = [1 + (\mu - 1)\alpha]p^2$, $(m = 1,3)$；The probability of a borrower's good credit when he chooses not to insure $P(G|a_3^m) = [1 + \beta((1 - \mu)\alpha - 1)] p^2/(1 - \beta)$, $(m = 2,4)$；The probability of a borrower's credit difference when he chooses insurance $P(B|a_3^5) = (1 - p)^2(1 - \alpha)$；The probability of a borrower's credit difference when he chooses not to insure $P(B|(a_3^6, a_2^7)) = (1 - p)^2 \left[1 + \frac{\alpha\beta}{(1-\beta)}\right]$.

It can be observed from a posteriori probability that when the same borrower does not know the real type of the borrower when he chooses the same behavior, when the observer is aware of the real type, $P(G|a_3^m) < P(B|a_3^5)$, $(m = 1,3)$, loaned borrowers and P2P network lending platform analysis, making an insurance action, indicating that the borrower is suspicious of the borrower's true credit type. When observed $P(G|a_3^m) > P(B|(a_3^6, a_2^7))$, $(m = 2,4)$, loaned borrowers and P2P network lending platforms are analyzed to make sure that the borrowers trust the borrowers' true credit types. The insurance system is introduced into the P2P net loan platform. The borrower will have the initiative to promote the benign development of the P2P net loan platform. The borrower observed the behavior of the borrower, which tends to submit the real and effective material, and the default risk of the P2P net loan platform will be reduced.

3.4 Regulatory system of the Central Bank of the government

When the Central Bank of the government registers the P2P net loan platform, it also needs to sign the agreement of the central bank supervision platform current account in addition to the deposit system, and regularly checks the default rate of the P2P net loan platform. Because P2P network lending platform depends on the real name registration of banking system, the cost of central bank regulation is low, and supervision is convenient. In line with the previous margin system, we should reduce the risk of default and ensure that the new Internet finance will play a healthy role in the world economy.

IV. CONCLUSIONS AND RECOMMENDATIONS

This paper mainly deals with the risk problems in the real Internet lending finance, and analyzes the game and government intervention among the participants in the net loan, and puts forward the following suggestions.

(1) establish a margin system to improve the qualification of the third party online lending platform. According to the operation scale of the platform, the lower limit is set for the entry of the market. The platform for entering the market will pay the margin according to the

regulations. The platform has been entered into the market to meet the requirements of the government P2P net loan platform to make up the security deposit, and strictly control the risk oriented P2P net loan platform into the market. On the basis of paying the deposit, the platform will set an example and strictly control the credit checking of the borrowers, so as to prevent unnecessary default risks. The government's platform constraint effect not only promotes the P2P network loan platform to become a dominant lending channel, but also improves the national tax revenue, which helps to develop the benign credit market. Those platforms that will not meet the above requirements will be eliminated, which will help to reduce the number of third party lending platforms that are not qualified in the market and prevent uncontrollable risks.

(2) to promote the insurance system of P2P net loan, the insurance industry is willing to cooperate with the high quality third party lending platform to launch lenders' insurance business. On the basis of strict verification of the P2P network loan platform and effectively reducing the default rate, we will make a breach of contract compensation for the unavoidable default business. The insurance industry will also review it, and the P2P credit platform word-of-mouth makes its development more durable. Borrowers will observe this behavior, and will realize that the possibility of providing false information is less and less likely to be perceived, thereby reducing the possibility of credit poor borrowers entering the market.

(3) the introduction of the government and central bank to supervise the P2P net loan platform current account agreement, to investigate the transaction accounts of the frequently applied borrowers, and to avoid the possibility of the P2P net loan platform to intervene in illegal fund-raising or commercial fraud.

(4) advocate P2P network loan platform system audit and manual audit parallel. In the era of Internet finance, more and more new users use fast network to apply for loans. The P2P network loan platform should establish a more rapid and accurate audit system to improve the screening rate.

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Yongfei Li, College of Mathematics and Statistics, Northwest Normal University,Lanzhou,China,86-18393817413