

Peer to Peer Lending Supervision Analysis base on Evolutionary Game Theory

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Abstract

Aiming at the current market situation of China P2P industry, this work establishes the evolutionary game model between regulator and P2P lending enterprises, and analyzes the dynamic game characteristics between them. Research results show that strengthening the punishment force for the illegal P2P lending enterprises is beneficial to construct a stable and excellent balance. Setting up reasonable system, suitable reward and punishment mechanism, decreasing supervision cost, increasing the utility of the regulators, can achieve a satisfying game balance. This work can provide theory base and reference for the financial regulators to legislate the supervision policies and design relative rules for the P2P lending platform.

Keywords: *Peer to peer lending, game theory, borrow and lend, dynamic balance.*

1. Introduction

Since the world first peer to peer (P2P) lending platform was established in 2005, P2P lending market appeared in many countries gradually and developed rapidly. P2P means one network financial manner that money lenders provide pretty loan and collect certain interests to other borrowers through the third network P2P lending [1]. P2P lending market entered China in 2007, recently, under the driving of the development of the internet finance, development and innovation of the P2P lending market are very fast. Due to its convenience and low threshold, and the difficult loan resulting from the national banks tightening the credit and loan, P2P lending platform receives the warm welcome from the medium and small investors since it appears [2].

However, from the perspective of the P2P lending development in many countries, market risks of the system, platform and borrowers and lenders has appeared gradually. At the same time, for the various reasons of laws and regulations, and the credit system, innovation of the P2P lending market in China concentrates its risk on the platform operation and manipulation. In the past two years, in China P2P lending market, P2P lending platform closing down, difficult cashing, and the operators escaping with

the money appeared frequently, which shows that the development of the P2P lending market is wrapped and the advantages of the P2P lending market have not displayed [3]. Therefore, how to correct the existing problems in P2P lending market through reasonable supervision becomes a common problem among the superintendent, practitioner and researchers.

In 2008, the securities and exchange agent of the USA punished the famous P2P lending platforms, Prosper and Lending club [4]. Since then, they began to supervised the P2P lending, and the supervision criterion is <the Securities Law>. In UK, financial conduct authority (FCA) is the main superintendent of the P2P lending industry. Nowadays, UK is establishing the law to supervise the P2P lending further [5].

At one hand, due to its low threshold, loose supervision and larger market demanding, P2P lending industry emerges crazy increasing. At the other hand, the related supervision, laws and regulations are still absent. So this work discusses the interactive relation between the superintendent and the P2P lending institution in the P2P lending industry with the game theory, finds the balance point between the two sides, reveals the important influence factors of the effective superintendent, provides theoretical gist in legislating the corresponding laws and regulations, supervision policies for the related superintendents.

2. P2P lending supervision evolutionary game model

It conforms to the real situation to study the game between P2P lending enterprises and the government regulators using the evolutionary game theory. Through studying the dynamic procedure of swarm evolution of P2P lending enterprises and the government regulators, and explaining why and how the swarm can reach some states, this work expires to account for the problems in P2P lending supervision, forecast the future development tendency, and

provide suggestions for the government to better solve the problems.

Table 1 shows the utility matrix between the P2P lending enterprises and the government regulators. In order to construct the model and to analyze the game, we assume that:

- (1) The game sides are the P2P lending enterprises and the government regulators, and they are both limited rational.
- (2) Strategy space of the P2P lending enterprises are legal or illegal, their probability are presented by θ and $1-\theta$, respectively.
- (3) Strategy space of the government regulators are supervision or un-supervision, their probability are presented by λ and $1-\lambda$, respectively.

Table 1 Utility matrix between P2P lending enterprises and government regulators

		Government regulator	
		Supervision λ	Un-supervision $1-\lambda$
P2P Lending	Legal θ	$r - c - c_1, s - v$	$r - c - c_1, s$
	Illegal $1-\theta$	$-c - g, s - v$	$r - c, 0$

Where, r is the enterprise interest, c denotes the enterprise fixed cost, c_1 is cost increment due to legal operation, g is the punishment from the regulators for its illegal operation, s is tangible and intangible utility after the regulator executes the supervision, v is the supervision cost. It is assumed $s > v$, so it is clear that r, c, c_1, g, s and v are all larger than 0.

3. Evolutionary game analysis

3.1 Dynamic analysis of the P2P lending enterprise

According to the former assumption, probability that the P2P lending enterprise adopts the legal strategy is θ , probability of the illegal strategy is $1-\theta$. Then, desired utility and swarm average utility of adopting the two strategy game sides are depicted as follows:

$$u_{f1} = \lambda(r - c - c_1) + (1 - \lambda)(r - c - c_1) = r - c - c_1$$

$$u_{f2} = \lambda(-c - g) + (1 - \lambda)(r - c)$$

$$u_f = \theta(r - c - c_1) + (1 - \theta)[\lambda(-c - g) + (1 - \lambda)(r - c)] \tag{1}$$

The duplicate dynamic procedure of the P2P lending enterprise using the legal strategy can be denoted as:

$$\begin{aligned} \frac{d\theta}{dt} &= \theta(u_{f1} - u_f) = \theta\{(1 - \theta)(r - c - c_1) \\ &- (1 - \theta)[\lambda(-c - g) + (1 - \lambda)(r - c)]\} \\ &= \theta(1 - \theta)[(g + r)\lambda - c_1] \end{aligned} \tag{2}$$

According to (2), when $\lambda = c_1/(g + r)$, $d\theta/dt = 0$, it means all θ are in stable state. If $\lambda \neq c_1/(g + r)$, then $\theta^* = 0$ and $\theta^* = 1$ are two stable states, and when $\lambda < c_1/(g + r)$, $\theta^* = 0$ is evolutionary stable strategy (ESS), and when $\lambda > c_1/(g + r)$, $\theta^* = 1$ is ESS.

Three phase schemes in figure 1 show the dynamic tendency and stability of the P2P lending enterprise under the above three cases.

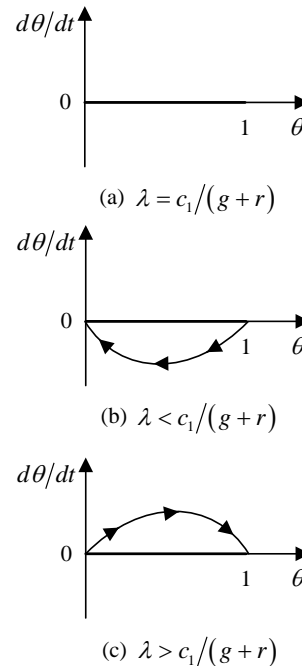


Fig. 1 Swarm duplicate dynamic phase of the P2P lending enterprise

3.2 Dynamic analysis of the regulator

Desired utility of the government regulator is:

$$u_{g1} = \theta(s - v) + (1 - \theta)(s - v) = s - v$$

$$\begin{aligned}
 u_{g2} &= \theta s + (1-\theta)0 = \theta s \\
 u_g &= \lambda(s-v) + (1-\lambda)\theta s
 \end{aligned}
 \tag{3}$$

Dynamic change speed of the regulator adopting the supervision strategy is:

$$\begin{aligned}
 \frac{d\lambda}{dt} &= \lambda(u_{g1} - u_g) \\
 &= \lambda[(s-v) - \lambda(s-v) - (1-\lambda)\theta s] \\
 &= \lambda(1-\lambda)(s-v-\theta s)
 \end{aligned}
 \tag{4}$$

According to (4), when $\theta = (s-v)/s$, $d\lambda/dt = 0$, it means all λ are in stable state. When $\theta \neq (s-v)/s$, $\lambda^* = 0$ and $\lambda^* = 1$ are two stable states. When $\theta < (s-v)/s$, $\lambda^* = 1$ is the ESS, and when $\theta > (s-v)/s$, $\lambda^* = 0$ is the ESS.

Three phase schemes in figure 2 show the dynamic tendency and stability of the government regulator under the above three cases.

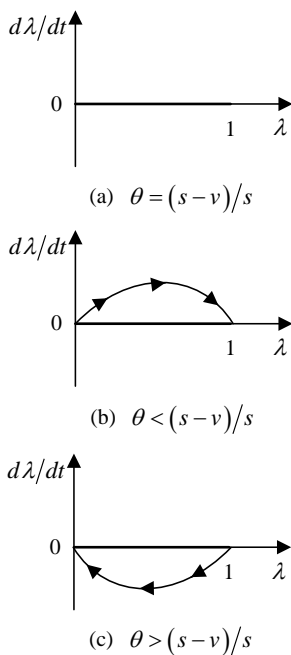


Fig. 2 Regulator swarm duplicate dynamic phase scheme.

Let $\theta^0 = (s-v)/s$, $\lambda^0 = c_1/(g+r)$, it is clear that $0 < \theta^0 < 1$. In different cases, we can display the duplicate dynamic relations and stability of the above two swarms in figure 3, with the two scales (λ and θ) as the coordinate axis.

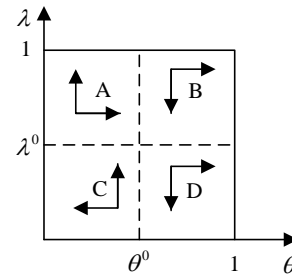


Fig. 3 Duplicate dynamic relation and stability of the P2P lending regulator game

3.2 Game sides evolutionary path analysis

For the government regulator, according to the figure 3, we can see that when $\theta^0 \rightarrow 0$, namely, s approaches v , government regulator's utility closes its supervision cost, and probability of $\theta > \theta^0$ increases greatly. The regulator tends to apply un-supervision strategy after the long evolutionary game, namely, $\lambda = 0$ is stable strategy. When the supervision cost of the regulator v is very small, $\theta^0 \rightarrow 0$, the evolutionary game locates in the left half part of the figure 3. Finally, it will get $\lambda = 1$, in other word, because there is almost no cost, the government will fully supervise.

Based on above analysis, in order to ensure the effective supervision of the government, there are two ways: ① decreasing supervision cost v as far as possible, it amounts to increase the supervision probability. In recent years, considering cost in government supervision is main content of the government supervision theory. Supervision without considering the cost is not actual. ② increasing the work utility s of the regulator, it needs them to work diligently, so they should get awards, as well as the publicity.

For the P2P lending enterprises, from figure 3, we can see that when $0 \leq c_1/(g+r) \leq 1$, the extra cost c_1 in order not to be illegal is as small as possible, or the sum of interest income of the P2P lending enterprise and the punishment for the illegal actions $(r+g)$ is as large as possible (λ^0 is as small as possible), probability of $\lambda > \lambda^0$ will be larger, P2P lending enterprise will reach stable state $\theta = 1$ (legal).

$\theta^* = (s-v)/s$ and $\lambda^* = c_1/(g+r)$ are two critical points. When $\theta^* = (s-v)/s$, utilities of illegal and legal operation of the P2P lending enterprises are identical, and there is no difference, so they maybe adopt any strategy. Similarly, when $\lambda^* = c_1/(g+r)$, utilities of supervision and un-

supervision of the government are identical, so they maybe do not care the supervision and the work quality totally depends on their attitudes.

From figure 3, we can see that when $0 \leq \lambda^0 < 1$, this supervision game has no evolutionary game stable strategy, i.e., there is no automatic evolutionary tendency which can make the government regulator and the P2P lending enterprises to adopt this strategy, and not affected by the external changing strategy. When $\lambda^0 \geq 1$, there exists evolutionary stable strategy $\theta^* = 0$, $\lambda^* = 1$ is convergence in duplicate dynamics and stable state with anti-disturbance. It means that when the cost with legal operation is too high, enterprises will choose illegal operation, but the regulators will execute full supervision. It will result in loss at both sides, and can not create social benefit which is the most reluctant situation.

4. Conclusion of the game model

Summing up the above analysis, after detailed analyzing the P2P lending supervision game, this work wants to seek the evolutionary stable strategy of this model. Based on the parameters set of this model, we can conclude as follows:

(1) P2P lending supervision game is a complex dynamic procedure, due to different benefits of different sides, it maybe produce totally different results finally.

(2) When cost of the illegal operation is too high, and the punishment force is too small, P2P tends to bad stable state of illegal operation gradually. In view of this, P2P lending enterprises decrease cost, government optimize the business environment, and increase the punishment force for the P2P lending illegal operations, all these actions will help to build a stable and excellent balance.

(3) When legal cost and its incoming of the P2P lending enterprise is lower than the punishment with legal operation, the case is very complex, and there is no definite balance state. Actually, with reasonable system, suitable reward and punishment mechanism, decreasing the supervision cost, increasing the utility of the regulator, all these will achieve satisfying game balance.

5. Suggestions

(1) Enforcing industry self-discipline and promote the industry transparency

As a new industry, industry transparency and self-discipline of the P2P lending play a key role in its maturing and healthy development. In industry self-discipline, except that the industry associations need to establish a series of self-disciplines and regulations to standardize the industry healthy development, and bear the responsibility of supervising and warning, it also needs to strengthen the information share among the enterprises in the P2P lending industry, and construct the credit information service share platform as soon as possible. Since the current P2P lending industry good and evil people mixed up, there exist a sea of platform self-financing, loan fraud, presenting a false appearance of the financiers, investors do not know where their money goes towards, so it produces great risk. Increasing the industry transparency is also the important measure to standardize the P2P lending industry development, especially in necessary financial data, money flow, operation correlation between related guarantee platform and P2P lending platform, etc.

(2) Set up the admittance mechanism, increase the intensity of punishment.

Nowadays, risk resistance of registered capital in a multitude of the new P2P lending firms is very low. After its construction, if it meets large quantities of redemption operation applications, or credit receivers break the contracts, P2P lending firms maybe close down or run away. Therefore, the regulator should set up the admittance mechanism as soon as possible, strengthen to filtrate the enterprises. At the same time, as a financial innovation, too harsh admittance mechanism is disadvantageous to development of the P2P lending industry, so the regulator needs to take the supervision tolerance degree into account sufficiently. Meanwhile, if the enterprises appear illegal phenomenon during their operation, the regulator should increase the intensity of punishment to warn them.

(3) Enforce enterprise risk inner control, perfect risk management mechanism

Risk control is a key factor in P2P lending health development, except several large mature P2P firms, most P2P firms have a limited scale and use their limited capital to operate, so they only have relatively limited budget fund to invest the risk management, but the strength of the risk management determines the success or failure of the P2P lending platform directly,

Hence, establish perfect risk management mechanism, determine and standardize the industry risk indices, strictly control the information of the credit receivers in advance, multi measures are carried out to promote the enterprises risk control capacity.

Chinese P2P lending enterprises develop lag, credit receivers maybe use the platform to collect capital illegally, the lending platform maybe self-financing and becomes quasi financial intermediary (or serves as credit transform). Because the investors are mostly risk abhorrer, in order to maximize the profit, attract the investors, expand the market share, P2P enterprises strive for more clients through choosing guarantee operating mode. But, hiding problems behind the guarantee mode should not be ignored, such as unclear guarantee right subject, guarantee firm being also the related ones, self-financing, etc, are not supervised, even there is fake guarantee platform. The regulators definitely point put that P2P lending platform would act as information intermediary instead of the credit intermediary.

Game theory research between the enterprises and the regulators shows that in enterprise guarantee mode, whether there exist the guarantee enterprises are the related ones greatly relies on the supervision degree and punishment strength of the regulator. there is no doubt that deterrent force of the regulator affects the enterprises' profit, hence influence the operating mode choosing of the lending enterprises. Regulator should perfect the supervision system, strengthen the supervision force, improve the industry threshold, assess the lending platform credit system, draw up the risk supervision indices of the lending enterprises, etc, to construct excellent P2P lending financing environment.

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