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Evolution and simulation analysis of co-opetition behavior of E-business internet platform based on evolutionary game theory

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Abstract Both e-business internet platforms and commercial banks are the leaders of supply chain finance model, this paper analyzed the competition and cooperation behavior of those leaders by using evolutionary game theory and ABM. The main conclusions of the study are as follows: newly added income produced by cooperation and reward income given by government have positive effect on cooperation behavior; when one participant chooses cooperation and the other chooses competition,the added income for competing participant and the decreased income for cooperating participant have negative influence on cooperation behavior; when the allocation proportion of newly added income produced by cooperation is more fair, the cooperation behavior is easier to be promoted; when the income produced by cooperation is far bigger than competition, the cooperation strategy has a strong advantage. Finally, some suggestions have been proposed to promote the cooperation of e-business internet platforms and commercial banks.

Keywords E-business internet platform · Commercial bank · Competition and cooperation behavior supply chain finance · Evolutionary game · Simulation

1 Introduction

The Leaders of traditional supply chain finance used to be commercial banks, but with the progress of big data, cloud computing and other Internet-related technologies, there have been various changes in the realization form of supply chain finance, with these changes,a new supply chain finance has come into being,in which e-business internet platforms are the core participants. This supply chain finance began to appear. This new supply chain finance has two advantages: on one hand, it can use the Internet effectively to break the limitations of time and space, and it is convenient to find sources of funding for borrowers of credit; on the other hand, it can take full advantage of the structure of supply chain finance to carry out risk management and control, and help lenders control business risk. Therefore, in practice, especially in the large data condition, supply chain finance based on Internet platform e-business suppliers has made great progress, showing vitality in the ascendant. The main representative enterprises are Ali small loans (2010), Jing baby (2013) and Poly network (2014) and so on, which of them have achieved good results.

For the supply chain companies, under new technical conditions, they can choose to take participate in the supply chain finance which is dominated by commercial banks or e-business internet platform, so it is no doubt that complex competition and cooperation behaviors between commercial banks and e-business internet platforms will emerge., for supply chain financing customers.In the practice of supply chain finance of our country, it can be easily observed that there are two typical competition and cooperation behaviors between the two leaders:

① Cooperation. e-business internet platform and commercial banks used their respective advantages, and reached a cooperation agreement to supply financing service for supply chain companies. In cooperative mode, the main advantage of commercial banks is that they can provide enough fund; when it comes to e-business internet platform, the main advantages are their data (a variety of data is accumulated by supply chain companies completing business transactions through the platform), the funds of commercial banks can achieve effective risk avoidance under the data security of

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e-business internet platform. What's more, both of them can surely gain financing in return from supply chain companies. For example, in 2007, ICBC had cooperation with Ma Yun's company, Ali, jointly launched the SME unsecured and unsecured financing based on B2B and B2C. ② Competition.Commercial banks and e-business internet platform were separately using their own advantages leading supply chain finance. For commercial banks, it is still facing a problem of switch from the traditional offline mode to Internet-based online mode. Under the new technological environment, commercial banks are stepping up to imitate e-business to build their own supply chain finance platform, and grab the broad market of supply chain finance. For example, in 2012, CCB launched the "good financial business enterprise (for business), personal Mall (for individuals)". In 2014, ICBC launched the "Financial e shopping". All of them are the typical example for commercial banks to switch supply chain finance from the traditional offline mode to Internet-based online mode. For e-business internet platform, they mainly rely on their own capital and deposited funds on the platform to service for the supply chain of small and micro enterprises. From the current point of view, due to e-business internet platform has accumulated plenty of operational management experience, and form a more scientific and rational management system, while commercial banks due to various reasons, its conversion of idea is slow, the operation of the online platform is totally at an early stage of development. Then, in the competition among the financial supply chain, e-business internet platform has advantage, while commercial banks are in the catch position. This paper used evolutionary game theory and ABM, to analyze the competition and cooperation behavior of between commercial banks and e-business internet platform and find out the balance of it,and proposed some suggestions to promote the cooperation of e-business internet platform and commercial banks at the same time.

2 Related literature review

Early research focused on the following two aspects:

① The research for supply chain financial model led by e-business internet platform. These studies focus on this model's characteristics, elements, benefits, processes, and business mode of operation etc. Allen [1] thought that compared with traditional supply chain finance, supply chain financial model based on e-business internet platform has three characteristics:

First, the critical points of risk control are different. With the role of decline of the core supply chain business as a core risk control variable, big data and the credit system, based on trading platform, has become the key of risk control; Second, the role of the organizer was of duality, its organizer plays a dual role: manager of e-business platform, providers of financial services; Third, the service object of credit was specific. Its service object of credit usually was the companies trading in the e-business platform led by e-business or commercial banks. Ambarkhane [2] summarized four elements involved in the pattern: big data, e-business platform, capital supply side and demand side, discussed the mode's special risks and possible supervising pattern. Komarova [3] thought that Lending quick, low operating transaction costs, easy to manage risk are the three advantages of this mode. Rahman [4] pointed out that there are five process of the mode: supply chain companies applying for the loan, the platform auditing enterprise's data, communicating remotely through video, evaluating credit based on transactions data, the platform offering loans; Using the data accumulated by the platform, to check and offer micro-loan, is the basic features of the model; And according to operation of the process of the mode, put forward a series of risk control measures for examination and approval and supervision. Sethi [5] summed up Internet supply chain finance has seven business model: Internet finance of banks, Jingdong financial, Octopus foreign trade financing,transportation corporation finance, logistics special line e-business, retail supply chain finance and big data credit; predict its future trends: platform, participate in diversification, diversification of funding sources and the use of big data.

② The research for Commercial Banks develop new supply chain finance. Michael [6], Tan [7] and Brenner [8] thought that in the era of big data, the traditional supply chain finance should keep pace with the times, adapt to the changes in the new environment and make a thorough change. Commercial banks should actively respond to vigorously develop new supply chain finance, which is mainly made up of online operations and based on Internet platform. Hodgson [9–12] considered that the new technologies make a significant difference on traditional supply chain finance, they discussed some of the advantages of the new supply chain finance, and analyzes some typical mode of operation of the new supply chain finance. Smith [13] studied how commercial banks carry out small micro-enterprise financial under the condition of the Internet. And she indirectly analyzed several types of new supply chain finance credit operation mechanisms. Boyd [14] highlighted that the development of new commercial bank supply chain finance must satisfy the conditions of supervision, without violations. Weibull [15,16] argued that commercial banks, building Internet-based supply chain finance platform, should take example by the successful experience of e-business platform and take care of unfavorable lessons, for the supply chain of small and micro enterprises to provide more thoughtful financing and related services.

Seen from the above study, few scholars (or insiders) analyzed the competition and cooperation relationship between

these two types of subjects from the perspective of competition between commercial banks or e-business internet platforms for supply chain finance market. This article will do a study from this perspective.

3 The evolutionary game theory model of competition between commercial banks or e-business internet platform for supply chain finance market

3.1 The basic premises and assumptions

① The two main types of supply chain finance market to compete: E-business Internet platforms and Commercial Banks.

Based on current situation, this article assumes that both of these two categories of members were the heterogeneity of the body and were not fully rational individuals, they take participate in the supply chain financial markets according to the principle of benefit maximization. These individuals have a certain ability to learn in a random game process, and under conditions of asymmetric information, they can correct their behavior.

② The collection of E-business Internet platforms and Commercial Banks' action: $\{cooperation, competition\}$.

Regarding to e-business internet platform, its specific cooperative behavior can be that it strategically cooperate with commercial banks, to ensure commercial banks can be supported in terms of capital, and share the critical data of supply chain business with commercial banks on their own platforms, and cooperate to prevention and control and develop supply chain finance business. Its specific competitive behavior could be that it will rapidly develop e-business (B2B and B2C) based on its own platform, and constantly attract supply chain enterprises to take participate, and compete with commercial banks for a large number of customers, and use a variety of means to enhance user stickiness of the platform. In addition, it also organize financial ecology loop based on their own platforms, and cooperate with other potential or real fund pool (such as the deep cooperation between Ali and Celestica fund), using so many new technology which is based on big data, cloud computing and mobile Internet, to supply quick and convenient financial services for small and micro enterprises of the supply chain.

When it comes to commercial banks, their specific cooperative behavior could be that they provide various incentives for the use of e-business Internet platform(such as raising the transferred amount of funds, relaxing the time of use of funds, reducing the use of funds of various fees, attracting e-business Internet platform's deposits through incentives, etc.);they also deeply cooperate with e-business Internet platform to carry the supply chain finance related business(loans before the review, the loan in for examination and approval and post-loan supervision). Their specific competitive behavior could be that they are deeply involved in the original supply chain, stabilizing their supply chain customers, while under conditions of modern technology, they accelerate the transformation, and build their own e-business platform, and absorb new and old supply chain enterprises; Meanwhile, they use kinds of tools to increase the using cost of capital of e-business Internet platform.

③ The game benefit setting and payment matrix of e-business platforms and commercial Banks

According to the collection of two subject's strategies, the two sides of the game players benefit can be divided into four cases: the first case is that both sides are taking competition approach, we set the benefit of both parties are: commercial banks are Is, e-business Internet platform are Id; the second case, commercial banks choose to compete while e-business Internet platform choose to cooperate, now comparing with the first case, the benefit of e-business Internet platform will reduce and the benefit of commercial banks will increase. The reason is that, after e-business Internet platform shared the supply chain enterprise related information with commercial banks, commercial banks will use these shared data distribute several supply chain enterprise taking part in its leading supply chain finance. At the meantime, commercial banks take competitive measures against e-business Internet platform, to take various measures to limit the ability of e-business Internet platform developing supply chain finance. We set the reduction of benefit of e-business Internet platform is Md, the increase of benefit of commercial banks is As; the third case, commercial banks choose to cooperate while e-business Internet platform choose to compete, which against the second case. We set that the increase of benefit of e-business Internet platform is Ad, the reduction of benefit of commercial banks is Ms; the fourth case, the two sides are taking cooperation means, and the market of supply chain finance will be orderly development, both sides benefit will increase(compared with the first case), the game players will allocate the increasing benefit through agreement. The author set the addition of benefit is Z, use c to show the distribution coefficient, c^*Z means the amount of benefit commercial banks shared, $(1-c)^*Z$ for the amount of benefit e-business Internet platform shared($0 < c < 1$). It is worth to say that in order to promote the benign development of the supply chain of financial markets, the relevant regulatory authorities generally will restrict competitive behavior of game players and encourage cooperative behavior. We set an amount of rewards and punishments $F(F > 0)$.

According to the setting, Game payoff matrix of e-business Internet platforms and Commercial Banks can be expressed as the following table:

Table 1 The Game payoff matrix of Internet supply platform and commercial banks

E-business Internet platform	Commercial banks	
	Competition	Cooperation
The Game payoff matrix		
Competition	(Id, Is)	$(Id + Ad - F, Is - Ms + F)$
Cooperation	$(Id - Md + F, Is + As - F)$	$(Id + (1 - c)^*Z, Is + c^*Z)$

3.2 Evolutionary game model

Weibull [15] pointed out that the key concepts of evolutionary game theory are Replicator Dynamics (abbreviated as RD) and Evolutionarily Stable Strategies (abbreviated as ESS). In practice, RD is usually expressed in the game as a Differential which means frequency a specific strategy to be adopted in a group. If the subject,who taken part in the game, have a long period of learning and evolution, until any individual involved in the game are willing to change their choice, this convergence stabilize strategy is ESS. According to the assumption of the foregoing, e-business Internet platform and commercial banks compete for the markets of supply chain finance, this behavior can be analyzed by evolutionary game theory. For ease of analysis, I assumed that among e-business Internet platform,there are $p(0 \le p \le 1)$ratio choose to cooperate, and among commercial banks group,there are $q(0 \le q \le 1)$ratio choose to cooperate (of course, under certain circumstances, can be understood as the probability of a mixed strategy). According to Table 1's benefit, the following evolution of the analysis can be performed.

We regard the benefit when e-business internet platform choose to cooperate as DH, when e-business internet platform choose to compete as DD,and the average income recorded as DP.

$$\begin{aligned} DH &= (1-q)^*(Id - Md + F) \\ &\quad + q^*(Id + (1-c)^*Z) \end{aligned} \tag{1}$$

$$DD = (1-q)^*Id + q^*(Id + Ad - F) \tag{2}$$

$$\begin{aligned} DP &= \mathrm{p}^*DH + (1-\mathrm{p})^*DD \\ &= p^*q^*((1-c)^*Z + Md - Ad) + (F - Md)^*p \\ &\quad + (Ad - F)^*q + Id \end{aligned} \tag{3}$$

We regard the benefit when commercial banks choose to cooperate as SH, when e-business internet platform choose to compete as SD,and the average income recorded as SP.

$$SH = (1-p)^*(Is - Ms + F) + p^*(Is + c^*Z) \tag{4}$$

$$SD = (1-p)^*Is + p^*(Is + As - F) \tag{5}$$

$$\begin{aligned} SP &= q^*SH + (1-q)^*SD \\ &= p^*q^*(c^*Z + Ms - As) + (F - Ms)^*q \\ &\quad + (As - F)^*p + Is \end{aligned} \tag{6}$$

By the Formulas (1)–(3) and (4)–(6) can be obtained that the replicator dynamics equation (Dynamic Differential) of e-business Internet platform and commercial banks respectively.

The replicator dynamics equation of e-business Internet platform is as follow:

$$\begin{aligned} dp/dt &= p(DH - DP) \\ &= p^*(1-p)^*(q^*(Z^*(1-c) - Ad + Md) \\ &\quad + F - Md) \end{aligned} \tag{7}$$

The replicator dynamics equation of commercial banks is as follow:

$$\begin{aligned} dq/dt &= q(SH - SP) \\ &= q^*(1-q)^*(p^*(Z^*c - As + Ms) \\ &\quad + F - Ms) \end{aligned} \tag{8}$$

3.3 Equilibrium point and stability analysis

Simultaneous copy dynamic equations (7), (8), and orders $dp/dt = 0, dq/dt = 0$. Because of the restrictions of $p(0 \le p \le 1)$ and $q(0 \le q \le 1)$, from a purely mathematical point of view, the equilibrium point of the system has four and five in both cases.

3.3.1 Four equilibrium point

If $(-F + Md)/(Z^*(1-c) - Ad + Md) < 0$ or $(-F + Ms)/(Z^*c - As + Ms) < 0$;$(-F + Md)/(Z^*(1-c) - Ad + Md) > 1$ or $(-F + Ms)/(Z^*c - As + Ms) > 1$, the system has four Equilibrium point,they are O(0,0), A(1,0),B(1,1),C(0,1).

① When $F > \min(Md, Ms)$,$(Z^*(1-c) > Ad - Md)$ and $(Z^*c > As - Ms)$, or when $(Ad - F < Z^*(1-c) < Ad - Md)$ and $(As - F < Z^*c < As - Ms)$, then, the Equilibrium point is point O(1,0), and point B(0,1) is unstable point, while point A and point C is saddle point.

② When $F < \min(Md, Ms)$, $(Z^*(1-c) < Ad - Md)$ and $(Z^*c < As - Ms)$, or when $(Ad - F > Z^*(1-c) > Ad - Md)$ and $(As - F > Z^*c > As - Ms)$, then, the Equilibrium point is point B(1,0), and point O(0,1) is unstable point, while point A and point C is saddle point.

③ When $F > Md$, $(Z^*(1-c) > Ad - Md)$ and $(As - F > Z^*c > As - Ms)$, or when $F < Ms$, $(Z^*c < As - Ms)$ and $(Ad - F < Z^*(1-c) < Ad - Md)$,then, the Equilibrium point is point A(1,0), and point C(0,1) is unstable point, while point O and point B is saddle point.

④ When $F < Md$, $(Z^*(1-c) < Ad - Md)$ and $(As - F < Z^*c < As - Ms)$, or when $F > Ms$, $(Z^*c > As - Ms)$and$(Ad - F > Z^*(1-c) > Ad - Md)$, then, the Equilibrium point is point C(1,0), and point A(0,1) is unstable point, while point O and point B is saddle point.

To avoid having a discussion without practical meaning, the author further make an assumptions based on reality:first, regulatory authority rule the incentive value F of those e-business Internet platforms (commercial banks) adopted a cooperative countermeasures does not exceed the value of their losses, existing $F < \min(Md, Ms)$; second, generating through the cooperation of e-business internet platforms and commercial banks, the individual's benefit increasing more than when one select competition, satisfying $\min(Z^*c, Z^*(1-c)) - \max(Ad, As) > 0$. Based on these two additional assumptions, we can see that the premise of the four equilibrium point analysis does not hold.

3.3.2 Five equilibrium point

$$J = \begin{bmatrix} (1-2p)^*(q^*(Z^*(1-c) + Md - Ad) + F - Md) & p^*(1-p)^*(Z^*(1-c) + Md - Ad) \\ q^*(1-q)^*(Z^*c + Ms - As) & (1-2q)^*(p^*(Z^*c + Ms - As) + F - Ms) \end{bmatrix}$$

According to the former two new added assumption, we can know that $0 < (-F+Md)/(Z^*(1-c)-Ad+Md) < 1, 0 < (-F+Ms)/(Z^*c-As+Ms) < 1$, the system has five Equilibrium point: O(0,0),A(1,0),B(1,1),C(0,1),D($\frac{(-F+Ms)}{(Z^*c-As+Ms)}$, $\frac{(-F+Md)}{(Z^*(1-c)-Ad+Md)}$).Whether Equilibrium point is stable can be analyzed by Jacobian matrix, we can use Matlab software carry out Jacobian matrix,as follows:

$$J = \begin{bmatrix} (1-2p)^*(q^*(Z^*(1-c) + Md - Ad) + F - Md) & p^*(1-p)^*(Z^*(1-c) + Md - Ad) \\ q^*(1-q)^*(Z^*c + Ms - As) & (1-2q)^*(p^*(Z^*c + Ms - As) + F - Ms) \end{bmatrix}$$

Respectively taking these five in the det J and trJ of the Jacobian matrix, and according to the judge law of stability of differential equation, we can get the following Table 2.

From the table we can see that there are two point ESS (point O and point B), and there is a saddle point (point D), and there are two unstable points (points A and C), in the vicinity of ESS point, random perturbation of system will not affect its convergence. According to the above equilibrium point analysis, it can be made dynamic evolution phase diagram of competition and cooperation behavior of e-business Internet platforms and Commercial Banks (Fig. 1).

Competition and cooperation behavior of e-business Internet platforms and Commercial Banks,which of them is in the end converge to ESS point, depend son two factors: the relative position between initial scale, the Game has different countermeasures, and saddle point D.

The initial ratio of both game players taken different countermeasures, may fall into four areas: the cooperation area (HDGB), the competition area (EDFO), (CHDE and GDFA). In the cooperation area, with the evolution,the initial ratio will eventually converge to point B (cooperative state); in the competition area, with the evolution,the initial ratio will eventually converge to point O (competitive state); in the variable area, with the evolution,the initial ratio will probably converge to point B or point O. If we want to know which point will it specific converge, other factors need to be added. In the general case, if the area of the cooperation area is greater than competition area, it may even more likely to converge to point B, on the contrary is more likely to converge to point O.

Next, we will analyze the factor of the influence of the saddle point D $\left(\frac{(-F+Ms)}{(Z^*c-As+Ms)}, \frac{(-F+Md)}{(Z^*(1-c)-Ad+Md)}\right)$: point D's value reverse change with Z(in partnership added benefit) and F(incentive and punish amount of competition and cooperation behavior ruled by regulatory authorities). When Z and F become larger, point D move toward point O, and the scope of the region ABCD increases, the point of the region will converge to point B(cooperative state). In particular, it is significant for the regulatory authorities to promote the development of rational and effective competition and cooperation behavior, through adjusting the F's value to a certain range; the value of point D forward changes with Ad(when the game stay in the third case, the added benefit of e-business Internet platform), Md(when the game stay in the second case, the reduced benefit of e-business Internet platform), As(when the game stay in the second case, the added benefit of commercial banks), and Ms(when the game stay in the third case, the reduced benefit of commercial banks). But when these four value become larger, the slope of ADCO is also bigger, and the point of the region will converge to point O(competitive state); cooperating bring out the change of distribution coef-

Table 2 Symbolic analysis of five equilibrium Jacobian determinant and trace

Equilibrium point	det J	Positive Negative	trJ	Positive Negative	Conclusion
O	$(F-Ms)^*(F-Md)$	>0	$2F-Ms-Md$	<0	ESS
A	$(Z^*c-As+F)$ $^*(Md-F)$	>0	$Z^*c-As+Md$	>0	Unstable
B	$(Z^*c-As+F)^*$ $(Z^*(1-c)-Ad+F)$	>0	$Ad+As-Z-2F$	<0	ESS
C	$(Z^*(1-c)-Ad+F)$ $*(Ms-F)$	>0	$Z*(1-c)-Ad+Ms$	>0	Unstable
D	$-\frac{(Md-F)^*(Z^*(1-c)-Ad+F)}{((1-c)^*Z-Ad+Md)^2}$ $*\frac{(Ms-F)*(Z^*(1-c)-Ad+Md)}{(c^*Z-As+Ms)^2}$ $^*(Z^*c-As+Ms)^*(Z^*c-As+F)$	<0	0	=0	Unstable

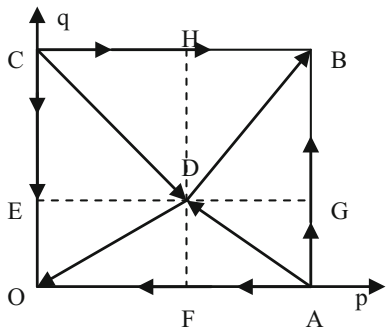

Fig. 1 Dynamic evolution of competition and cooperation behavior of e-business Internet platforms and Commercial Banks

ficient c of the new benefit Z, this will affect point D moving towards point A and point C. When c become smaller, point D will move to point A, which indicate that e-business Internet platform carve more cooperative benefit and commercial banks will be more inclined to choose competitive strategy, and vice versa yes.

4 Simulation analysis of evolutionary stability of different competing strategies

Although using analytical method,we can get accurate results for the evolution of competition and cooperation behavior of e-business Internet platforms and Commercial Banks, due to current situation is complex, the evolution of competition and cooperation behavior between game players is also complex. The writer will build simulation model based on a multi-Agent to describe competition and cooperation behavior between game players, focusing on the performance of different competing strategies in different situations. For simplicity, we assume that all Agents are hetegeneous, and each Agent only can remember the last strategies of their game opponents. Multi-Agent Game payoff matrix shown in Table 3 (obtained through the transformation of Table 1), because the game player is homogeneous, so we can see $Id = Is$,$Ad = As$,$Md = Ms$,$c = 0.5$, further assumed $F < \min(Md, Ms)$, combining additional assumptions of the foregoing $F < \min(Md, Ms)$, we can see $F = Ad = As < Md = Ms$.

By means of comparing, we can rank the values of payoff matrix in size, as follows: $Id - Md + F < Id < Id + 0.5^*Z$, you can also know that the game has two Nash equilibrium(Id,Id) and ($Id + 0.5^*Z$,$Id + 0.5^*Z$), separately corresponding to the state of point O(competitive state) and point B (Cooperative status) analyzed by the earlier evolutionary game. The author divide competition and cooperation strategies of Agent into four categories: first, competitive strategy, namely regardless of which side to take additional game strategies, the Agent always choose competitive strategy; second, cooperative strategy, namely regardless of which side to take additional game strategies, the Agent always choose cooperative strategy; third, the tip-to-head strategy, namely Agent initially selected cooperative strategy, and then choose the game opponent's strategy; and fourthly, no trust policy, namely Agent initially selected competitive strategy, and then choose the game opponent's strategy. Agent's cooperative and competitive strategy show in the Table 4.

In the specific simulation process, we tested 11 kinds of strategies to test equilibrium states under different strategies combinations of Agent's competition and cooperation evolution. The combination of several strategies are (cooperative strategy, Competitive strategy), (Competitive strategy, tip-to-head strategy), (Competitive strategy, no trust policy), (cooperative strategy, tip-to-head strategy), (cooperative strategy, no trust policy), (tip-to-head strategy, no trust policy), (cooperative strategy, Competitive strategy, tip-to-head strategy), (cooperative strategy, Competitive strategy, no trust policy), (Competitive strategy, tip-to-head strategy, no trust policy), (cooperative strategy, tip-to-head strategy, no

Table 3 Multi-agent Game payoff matrix

Agent 1	Agent 2	
	Competition	Cooperation
Game payoff matrix		
Competition	(Id, Id)	$(Id, Id - Md + F)$
Cooperation	$(Id - Md + F, Id)$	$(Id + 0.5^*Z, Id + 0.5^*Z)$

Table 4 Four cooperative and competitive strategy of multi-agent

Four cooperative and competitive strategy	Agent's first choice	The former choice of game opponent's behavior	
		Cooperation	Competition
Competitive strategy	Competition	Agent's next choice:Competition	Agent's next choice:Competition
Cooperative strategy	Cooperation	Agent's next choice:Cooperation	Agent's next choice:Cooperation
Tip-to-head strategy	Cooperation	Agent's next choice:Cooperation	Agent's next choice:Competition
No trust policy	Competition	Agent's next choice:Cooperation	Agent's next choice:Competition

trust policy), (Competitive strategy, cooperative strategy, tip-to-head strategy, no trust policy). These 11 combinations divided into two categories, one contains cooperation policy; another type doesn't contain cooperation policy. This paper use Netlogo software to simulate 961 (31*31) Agent group in its grid space, and each Agent randomly have four neighbors Agent game. Taken the realities(the benefit brought by cooperation between e-business internet platforms and commercial banks is larger than competition) into account, the author set the specific of assignment matrix for $Id = 5$, $Z = 10$, $F - Md = -1$. Based on the conclusions of the foregoing, we can calculate the position of the saddle point $(1/6, 1/6)$. For cooperative strategy combination, I emphasis testing two cases, for one is that the stability of policy combination at a critical of saddle point, for the other is that the stability of policy combination after average the group; For non-cooperative strategy combination, we only test a situation, namely the stability of policy combination after average the group. Simulate each of 11 kinds of strategies 10 times, tangible results in Table 5 below:

As can be seen from the table,most of the strategies combinations within cooperation type combinations are stable under critical situations,except one combination(cooperation,competition).Even in this strategy combination, it also converge to the optimal Nash equilibrium 7 times; Over other strategy combination in critical extreme cases, the amount of cooperative strategies are rising rapidly. From the view of number ratio, cooperative strategies have evident advantage towards no trust policy and competitive policy. Under the circumstances of averaging the number of Agent, cooperative strategy made the absolute advantage, have occupied the number of advantages in almost every kind of policy combinations. In non-cooperative class, competition policy reflected worst in the evolution of the number, next is no-trust policy. These two type strategy combination, converge to a suboptimal Nash equilibrium. he best performance is the tip-to-head strategy, its number of evolution obviously exceed competitive strategy and distrust policies. However, it should be noted that the above results are turned out in the condition of Game Payment $Z = 10$ and $Id = 5$. If the benefit Z brought out by the cooperation of e-business internet platforms and commercial banks is not too much than Id, the advantage of cooperation strategies and tip-to-head strategy will weaken, while the advantage of competitive strategies and no-trust policy will be reinforced. Of course, it is likely to converge to a suboptimal Nash equilibrium.

5 The suggestion of promoting e-business internet platforms and commercial banks benign cooperation in the supply chain finance market

In the modern technology background, the evolution of competition and cooperation behavior of e-business Internet platforms and Commercial Banks is determined by Z(added benefit from cooperation), Z's Partition coefficient c, F(the amount of incentives for competition and cooperation behavior from regulatory authorities), Ad(the proceeds to increase the amount of e-business Internet platform, when the game is in the third case), Md(the proceeds to decrease the amount of e-business Internet platform, when the game is in the second case), As(the proceeds to increase the amount of Commercial Banks, when the game is in the second case), and Ms(the proceeds to increase the amount of Commercial Banks, when the

Table 5 The stability of the evolution of the different category strategy combinations

category	Policy combination	Critical agent number	The stability of strategy combination	Average agent	The stability of strategy combination
Cooperation policy	Cooperative strategy	27	Unstable, converge to O point 3 times, converge to point B 7 times	480	Stable, converge to point B 10 times
	Competitive strategy	934		481	
	Cooperative strategy	27	27:934 Dynamic stability, the number stable at 27:934	480	480:481 Dynamic stability, the number stable at 480:481
	Tip-to-head strategy	934		481	
	Cooperative strategy	27	Dynamic stability, the number stable at (691–761):(200–270)	480	Dynamic stability, the number stable at (718–733):(228–243)
	No trust policy	934		481	
	Cooperative strategy	27	Dynamic stability, the number stable at (471–495):0:(466–490	320	Dynamic stability, the number stable at (585–595):0:(366–376)
	Competitive strategy	467		320	
	Tip-to-head strategy	467		321	
	Cooperative strategy	27	Dynamic stability, the number stable at (758–777):0:(184–202)	320	(250–265) Dynamic stability, the number stable at (696–711):0:(250–265)
	Competitive strategy	467		320	
	No trust policy	467		321	
	Cooperative strategy	27	Dynamic stability, the number stable at (267–329):(562–570):(80–124)	320	Dynamic stability, the number stable at (523–550):(319–324):(87–119)
	Tip-to-head strategy	467		320	
	No trust policy	467		321	
	Cooperative strategy	27	Dynamic stability, the number stable at (565–577): 0: (302–310): 74–94)	240	Dynamic stability, the number stable at (583–610):0:(233–248):(118–130)
	Competitive strategy	311		240	
	Tip-to-head strategy	311		240	
	No trust policy	312		241	
Non-cooperation policy	Competitive strategy			480	Dynamic stability, the number stable at (54–74):(887–907)
	Tip-to-head strategy			481	
	Competitive strategy			480	Dynamic stability, the number stable at 480:481
	No trust policy			481	
	Tip-to-head strategy			480	Dynamic stability, the number stable at (814–871):(90–147)
	No trust policy			481	

Table 5 continued

category	Policy combination	Critical agent number	The stability of strategy combination	Average agent	The stability of strategy combination
	Competitive strategy			320	Dynamic stability, the number stable at (40–48):(671–718):(213–242)
	Tip-to-head strategy			320	
	No trust policy			321	

game is in the third case). In the actual case, the total benefit when both of them choose to cooperate is greater than competition, but information asymmetry makes Game players difficult to trust each other, so as to converge to a suboptimal Nash equilibrium (which is a type of prisoner's dilemma), so resulting in a potential loss. The author believes that you can proceed from the following two aspects to push the cooperation of Game players in the market of supply finance.

①Based on the new benefit Z, bringing in bigger cooperation, it will be equitable distribution. Although our Agent conclusion show that the stability of the strategy of cooperation, this stability is based on a formula $\min(Id + (1 - c)^*Z, Is + c^*Z) >> \max(Id, Is)$, if Z is not large enough, the advantages of cooperation strategy will be significantly reduced.In our simulations, the less critical mass of 27 Agent adopt a cooperative strategy, they finally achieved good evolution effect, but if the formula is not satisfied, there must be a considerable critical amount of Agent adopt a cooperative strategy. Only in this way can it ensure the final form of cooperation. On the other hand, if one game player aggressively get more new benefit(that is to make one's own partition coefficient c greater), then the other game player will be more dynamic to select competition. The author believes that the distribution of the new benefit should be based on the contribution of game player. In general, at the beginning of the development of the new supply chain finance market, e-business Internet platform tend to invest more in the development of the market. If cooperating at this stage, commercial banks should give more profit to e-business Internet platform; at mature of development of the new supply chain financial market, both of them have a greater contribution, and the contribution may be more balanced. If cooperating at this stage, the game players should be a long-term point of view, and effectively solve the contradiction of the short-term, to achieve consistency of the overall interests.

② Relevant government departments should take measures to play a positive role. Regulatory authorities can lead from three aspects: first, adjust the incentive amount F, transfer large F, its meaning is to increase the penalties for bad competition behavior and increased the reward for the orderly cooperative behavior, transfer small F, its meaning is the opposite. To protect rational cooperation, regulatory authorities should intervene the behavior that commercial banks limit the development of e-business Internet platform, and support the behavior that both sides share resources and common develop supply finance; second, relevant government departments s an independent third party, in a detached outsider status, could play a unique role when they help Game players reduce information asymmetry. They also help e-business Internet platform and commercial banks correctly recognize the situation of the game, and get rid of the Prisoner's Dilemma, to achieve the best interests of both parties; third, as for the new benefit distribution, relevant government departments could take advantage of transcendent status and information to assist e-business Internet platform and commercial banks reached a long-term cooperation agreement.

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