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Original Paper

Evolutionary Game Analysis of Open Financing Models for Small and Medium-Sized Internet Education Enterprises

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Abstract

The open financing models combine traditional financing and network financing, which plays an important role in alleviating the financing constraints of small and medium-sized education enterprises and is conducive to promoting the growth of small and medium-sized education enterprises. Based on the systematic review of evolutionary game theory, the characteristics of evolutionary game theory and its differences with game theory, this paper first constructs the game process analysis of the open financing mode of small and medium-sized Internet education enterprises, and proposes the stabilization strategies of the participants through the model analysis. On this basis, the financing model is improved by introducing the constraints of individuals, loan companies, government and intermediaries, and the open financing game process is theoretically analyzed and mathematically derived. The conclusions of the study provide an important reference for promoting the open financing model of small and medium-sized Internet education enterprises.

Keywords

financing constraints, Internet education enterprises, evolutionary game analysis, open financing models

1. Introduction

In recent years, with the development of big data, information technology, sharing economy, etc., small and medium-sized Internet education enterprises continue to emerge, but they face high financing constraints in the process of development (Claudy, 2006; Tim Ogden, 2007; Wang Zijing, 2020; Zhang Yuming et al. 2022), and it is difficult to get financial support from traditional financing methods such as banks and stock market. Small and medium-sized Internet education enterprises face high financing constraints, mainly due to small scale, light assets, no collateral, information asymmetry, unsound financial system and imperfect information disclosure (Malnell & Hodgman, 1961; Baltensperger, 1978;

Diamond, 2002; Wang Hongsheng, 2022), and it is difficult to meet the basic requirements of traditional financing methods, such as bank loans and equity financing. And with the application of network technology, the rapid development of Internet finance has brought new opportunities for the innovation of financing mode of MSMEs (Christen, 2013; Ethan, 2014; Xu Jie et al., 2014; Deng Hongli, 2015; Wang Lihua et al. 2016; Xiang Dong, 2020), and P2P, crowdfunding and other online financing have become a new financing channel for MSMEs (Xie et al., 2012; Zhang Ling et al., 2015, Zhang Yuming et al. 2019). However, single-network financing also has problems such as information asymmetry, high risk, high interest rate, and unstable source of funds (Christen, 2013; Ethan, 2014; Xu Jie et al. 2014; Deng Hongli, 2015; Wang Lihua et al., 2016; Xie Pingping, 2012; Zhang Ling et al., 2015; Yu L, Zhang B, Yan Z et al., 2022), it should combine the traditional financing mode and network financing mode to build a financing structure that can effectively promote its continuous operation (Qianqian Chen, 2023). Based on this, this study proposes an open financing model applicable to small and medium-sized Internet education enterprises, which effectively integrates traditional financing and network financing. The details are shown in the following Figure 1:

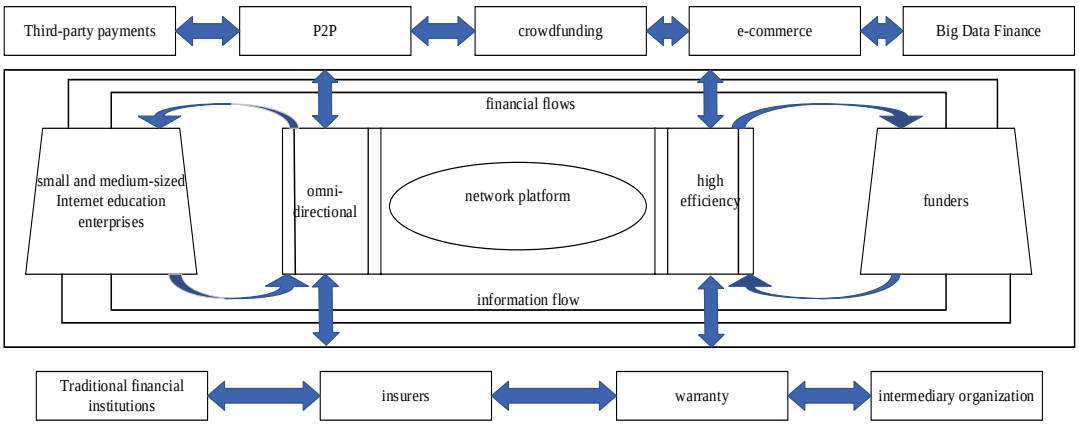

Figure 1. Open Financing Model Diagram

Combined with the theoretical analysis, this study considers that the open financing mode of small and medium-sized Internet education enterprises refers to the open, highly efficient and all-round financing mode, which can effectively alleviate the information asymmetry between the supply and demand sides of funds, relying on the Internet network platform and the participation of multiple subjects, such as enterprises, banks, insurance companies and network financing institutions, with full integration of information flow and capital flow, under the development of Internet technology, big data technology and communication technology.

It can be seen that the open financing model is a system of diversified subject participation, small and medium-sized Internet education enterprises and different participating subjects, there are game relationships between the participating subjects, so this paper is based on the theory of evolutionary game, the open financing game process of theoretical analysis and mathematical derivation.

2. Gaming Process of Open Financing Models for Small and Medium-sized Internet Education Enterprises

When the fitness of a certain performance type of a small and medium Internet education enterprise and a financing participant depends on its frequency distribution in the group, evolutionary game theory becomes an effective way to think about the problem of financing strategy from the perspective of the behavioral evolution of both parties. With the help of Weibull (1995), Nowak (2002) and other scholars' studies on evolutionary games, this section of the paper will clarify how small and medium-sized Internet education enterprises and financing participants can reach a stable state of cooperation in long-term evolutionary coexistence, which also provides the theoretical basis for the analysis in the following sections.

2.1 Process Analysis of Evolution

The evolutionary game model focuses on the dynamic evolution process of strategy frequency, arguing that the non-perfectly rational participants are able to continuously learn and evolve by collecting and acquiring more information. The evolutionary process of the game model can be broadly categorized into natural selection mechanism, imitation mechanism, and mutation mechanism.

2.1.1 Selection Mechanisms

At the stage of selecting the mechanism, both financing participants and small and medium-sized Internet education enterprises show that the strategy with higher expected returns is more adaptable than the strategy with lower expected returns. As we all know, the risk of small and medium-sized Internet education enterprises' investment projects, i.e. the probability of success of the project, is high and low, and in general, the lower the probability of success, the higher the return. When the enterprise applies for external financing, due to the existence of information asymmetry, it is difficult for fund providers to make accurate judgments about the financing behavior of small and medium-sized Internet education enterprises, especially the credit decision-making and credit management of high-risk projects, which will lead to adverse selection behavior. Enterprises default or do not default with a certain probability after receiving financing, of which default can be divided into subjective default and objective default. Although the only Nash equilibrium in a static game is the choice of the firm and the bank (default, no loan), the bank-firm game is a long-term dynamic choice process repeated many times, so repayment on schedule should be the best strategy for the firm. Based on the above analysis, a replicon dynamic simulation of the genetic effect and natural selection of groups E and B, determined by the fitness of the financing participants, can be established:

$$\dot{x}_i = x_i f_i^E(a_i, S^B) \tag{1}$$

$$\dot{y}_i = y_i f_i^B(b_i, S^E) \tag{2}$$

where x_i and y_i denote the number of participants in the group of small and medium Internet education companies and the group of funding participants, respectively, who adopt strategy i at time t,

a_i and b_i denote the value of the gain of the two groups adopting strategy i at time t, f_i^E and f_i^B are the corresponding fitness functions, expressed here in terms of the gain of a particular strategy given the distribution of strategies for a group. Thus, the total number of groups E and B is $N = \sum_{i=1}^{n} x_i$ and $M = \sum_{i=1}^{n} y_i$ Substituting, $x_i = P_i N$, $y_i = Q_i M$,N into the above equation yields the following equation, where $\overline{f^E}$ and $\overline{f^B}$ denote the average fitness of groups E and B, respectively:

$$\dot{P}_i = P_i[f_i^E(a_i,Q,M) - \overline{f^E}] \tag{3}$$

$$\dot{Q}_i = Q_i[f_i^B(b_i,P,N) - \overline{f^B}] \tag{equation 4}$$

2.1.2 Mechanisms for Imitation

The imitation mechanism models the imitation behavior of small and medium-sized Internet education enterprises and groups of financing participants in real economic activities. At the end of each game, the participants in the open financing model system will observe the results of the game and reflect on their own performance and the current overall state at a certain frequency, so as to decide the probability of choosing the strategy at the next moment. In this paper, we use $r_i(P)$ and $r_i(Q)$ to denote the average reflection rate of participants E and B using strategy i. The probability of participants E and B switching from strategy i to strategy j through reflection is denoted by $\delta_i^j(P)$ and $\delta_i^j(Q)$. Taking the group of small and medium Internet education enterprises in Beijing as an example, if the participants in this group simply imitate the strategies of the participants around them, then the reflection rate of the participants decreases linearly with their current benefits:

$$r_i(P) = \alpha - \beta f_i^E(a_i,Q,M) \qquad \alpha,\beta \in R, {}^{\alpha}/_{\beta} \geq f_i^E(a_i,Q,M) \tag{5}$$

where α is the value of the participant's return $r_i(P)$=0. The choice dynamics obtained from the above derivation is

$$\dot{P}_i = \beta[f_i^E(a_i,Q,M) - \overline{f^E}]P_i \qquad \beta > 0, \beta \in R \tag{6}$$

Similarly, the selection dynamics can be derived for the group of money providers. Since equations 5-6

are only normalized for the replication subdynamics, the results of the replication subdynamics in the selection mechanism hold for all participants who replicate by pure imitation. If the participants in the group of small and medium Internet education firms are not pure imitators, but compare their own gains to those of participants drawn with some probability, or are judged on the popularity of a particular strategy, then these participants are more likely to be randomly selected from the aggregate, given the bragging rights or real and visible gains of the more successful participants. Thus, a given participant is reflectively more likely to mimic the more successful firm with the highest returns in the current period, at which point for a given there is $\varepsilon、\phi \in R$, $\delta_i^j(P) = \phi + \varepsilon f_i^E \quad \varepsilon > 0$,so the selection dynamics are then modeled as mimicry replication by determining weights through returns:

$$\dot{P}_i = \frac{\varepsilon}{\phi+\varepsilon f_i^E}[f_i^E(a_i,Q,M) - \overline{f^E}]P_i \qquad \varepsilon、\phi \in R,\ \varepsilon > 0 \tag{7}$$

2.1.3 Mutation Mechanisms

The modeling process of the evolutionary game of the open finance model relies mainly on the selection mechanism, while the role of the mutation mechanism is more limited and is mostly used to test the stability of the evolutionary equilibrium. The introduction of random changes in the strategies of the participating subjects in the replicator dynamic model constitutes the corresponding replicator-mutator model:

$$\dot{P}_i = \sum_{j\neq i}^{n}\left[\varphi(i,j)P_j - \varphi(j,i)P_i\right] + P_i[f_i^E(a_i,Q,M) - \overline{f^E}] \tag{8}$$

$$\dot{Q}_i = \sum_{j\neq i}^{n}\left[\gamma(i,j)Q_j - \gamma(j,i)Q_i\right] + Q_i[f_i^B(b_i,P,N) - \overline{f^B}] \tag{9}$$

$\varphi(i,j)$ and $\gamma(i,j)$ denote the probability that strategy j mutates to i in populations E and B, respectively. $\varphi(j,i)$ and $\gamma(j,i)$ denote the probability that strategy i is transformed into strategy j. $\sum_{j\neq i}^{n}\left[\varphi(i,j)P_j - \varphi(j,i)P_i\right]$ and $\sum_{j\neq i}^{n}\left[\gamma(i,j)Q_j - \gamma(j,i)Q_i\right]$ then denote the overall effect of the two population mutation mechanisms on strategy i, respectively.

2.2 Evolutionary Stability Criteria

Existing research has not reached a consensus on the evolutionary stability criterion for interactions between multiple aggregates. Following Swinkels' (1992) relatively weak evolutionary stability criterion, it can be obtained by assuming that one participating individual is randomly selected from each of the small and medium Internet education firms and the funding agency at the time of each interaction:

Definition 1: A strategy combination s is evolutionarily stable if for each strategy combination $s' \neq s$,there exists a certain $\overline{\sigma_{x'}} \in (0,1)$,such that for all sums $\sigma \in (0,\overline{\sigma_{x'}})$, $\omega = \sigma s' + (1-\sigma)s$ then:

$$f_i(s_i,\omega_{-i}) > f_i(s_i',\omega_{-i}) \qquad i \in K \tag{10}$$

3. Analysis of Open Financing Game Model Construction for Small and Medium-sized Internet Education Enterprises

Based on the above theoretical analysis, this part constructs the evolutionary game model of open financing for small and medium-sized Internet education enterprises, in order to obtain the set of evolutionary stable game strategies for the finite repeated games between small and medium-sized Internet education enterprises and capital suppliers as well as relevant intermediaries under the constraint conditions. In the process of constructing the game model, it follows the simulation model simulation, which starts from the participation of two types of subjects, small and medium-sized Internet education enterprises and banks, and then gradually introduces the participation of other fund supplying subjects, intermediaries and other subjects to jointly form the game model of open financing for small and medium-sized Internet education enterprises.

3.1 Construction of Evolutionary Game Models

In the actual financing process, banks' lending behavior toward small and medium-sized Internet education enterprises is affected by information asymmetry and the dynamic relationship between enterprises and banks. In exploring the behavioral relationship between small and medium-sized Internet education firms and banks, this part of the study divides the game process into two distinct phases: the loan application phase and the loan repayment phase. In the loan application stage, the set of strategies of small and medium-sized Internet education firms includes: loan amount, loan term, and collateral. In fact, due to the impact of information asymmetry, especially small and medium-sized Internet education enterprises have a certain degree of information opacity, banks are often difficult to assess the authenticity of the information provided by enterprises, and it is usually necessary to assess and take appropriate countermeasures through a series of behaviors. In this regard, by the impact of moral hazard and adverse selection, banks appear "shy loan" is more common, even some relatively high-quality enterprises in the financing process is also easy to be affected. In the second stage of the game, the company's strategy has been added to the loan repayment, default and so on. With weak regulatory constraints on the demand side of capital, and especially without appropriate regulation, defaulting on the loan or applying for a new loan from another bank may become the optimal choice for the demand side of capital. However, for banks providing credit funds, when faced with defaults by small and medium-sized Internet education firms, they may have to choose to sell collateral assets or

recover from guarantors, and may even face an increase in nonperforming loans, a behavior that can be imitated by other individual firms.

3.1.1 Evolutionary Game Model of Traditional Financing Model

According to the previous analysis, compared with traditional SMEs, small and medium-sized Internet education enterprises have a stronger motivation for development, but they will also face a relatively higher risk and probability of failure than traditional enterprises. For the bank, under the premise of capital security, it will inevitably raise the entry threshold of loans in the face of higher capital risks. As a result, the assumptions of the evolutionary game model of financing small and medium-sized Internet education enterprises are as follows:

First, the bank cannot accurately judge the degree of risk of small and medium-sized Internet education enterprises (E_i), but it can know the success rate of the investment project (λ_i), i.e., it can know the investment return (σ_i) in case of success and the investment loss (Φ_i) in case of failure;

Second, small and medium-sized Internet education enterprises have their own capital size (C_i), a loan amount (D) financed by a bank, a loan cost of BD, a loan interest rate of r, a loan term of t, and a cost of capital rate of r_0;

Third, if a default occurs on an SME's failed investment, the SME's loan proceeds, if unsecured, are D'. In the case of collateralized securities, the bank receives an amount equal to G as compensation for loan losses.

Table 1. Evolutionary Game One-Stage Model (I)

	Strategy 1: Loans		Strategy 2: No Loans
	unsecured	secured	
Strategy 1: Default	$\lambda_i[D(1+k_i)+C_i]$-BD -DR_0	$\lambda_i[D(1+k_i)+C_i$-G]-BD G-DR_0	0，0
Strategy 2: Repayment	$\lambda_i[D(k_i$-R(t))+$C_i]$-BD $\lambda_i D(1+R(t))+DR_0$	$\lambda_i[D(k_i$-R(t))+$C_i]$-BD $\lambda_i[D(1+R(t))$-G]+G-DR_0	0，0

According to the above setting, the strategy choice S in the population, i.e. the ratio of defaults and bank loan approvals of small and medium-sized Internet education enterprises, is p1 and q1 (both are parameters greater than 0 and less than 1). Therefore, according to Table 1, the fitness functions (expected returns) of small and medium-sized Internet education enterprises when they adopt different strategies can be obtained, as well as the value of the average fitness. Similarly, the fitness function (expected return) and the value of average fitness can be obtained for banks when they adopt different strategies. Based on the fitness functions of SMEs and banks, the replication dynamic model of the population can be obtained:

$$\dot{P} = P_1(f_1^E - \overline{f^E}) = P_1(1-P_1)Q_1\lambda_i\left[D\left(1+R(t)\right)-G\right] \tag{11}$$

$$\overset{\bullet}{Q} = Q_1(f_1^B - \overline{f^B}) = Q_1(1-Q_1)\left\{\lambda_i\left[D\left(1+R(t)\right)-G\right]+G-DR_0-P_1\lambda_i\left[D\left(1+R(t)\right)-G\right]\right\} \quad (12)$$

The f in the above model represents the fitness of choosing strategy 1 and strategy 2. According to this model, the local equilibrium point of the group can be obtained. The proportion of firms using strategy 1 in the group of small and medium Internet education firms is stable at p1=0, 1 or q1=0. The proportion of banks using strategy 1 in the group of banks is stable at q1=0, 1 or p1=0.

3.1.2 Evolutionary Game Model of Small and Medium-Sized Internet Education Enterprises and Banks in the Presence of Regulation

The probability of small and medium-sized Internet education enterprises adopting default behavior is affected by the success rate of the investment project and the collateral situation. Small and medium-sized Internet education enterprises are generally characterized by small scale, lack of collateral, high risk, etc., and high uncertainty in the operation process. It can be seen that it is necessary to prevent or reduce the default behavior of small and micro, and to establish an effective regulatory mechanism in the first stage of the game, and the reduction of default behavior will help to establish a better credit relationship between enterprises and banks, thus improving the predicament of financing difficulties of small and medium-sized Internet education enterprises. With regulation, assuming that the cost of regulation is U, an individual who pays back on time is likely to receive an incentive of H, and vice versa, a penalty of -H is given. As a result, a two-stage model of the evolutionary game is obtained.

Table 2. Evolutionary Game Two-Stage Model (II)

		Strategy 1: Have regulation	Strategy 2: Unregulated
Strategy	1:	λi[D(1+ki)+Ci-G]-BD-H	λi[D(1+ki)+Ci-G]-BD
Default		G+λiH -DR0-U	G -DR0
Strategy	2:	λi[D(ki-R(t))+Ci+2H]-BD-H	λi[D(ki-R(t))+Ci]-BD
Repayment		λi[D(1+R(t))-G]+G-DR0-U	λi[D(1+R(t))-G]+G-DR0

Based on the above analysis, the fitness functions of the group of small and medium-sized Internet education firms and the group of banks adopting different strategies in the presence of a regulatory mechanism are computed, and in turn, the replication dynamics model is obtained.

$$\overset{\bullet}{P} = P_1(f_1^E - \overline{f^E}) = P_1(1-P_1)\lambda_i\left[D\left(1+R(t)\right)-G-2HV_1\right] \quad (13)$$

$$\overset{\bullet}{V} = V_1(f_1^B - \overline{f^B}) = V_1(1-V_1)(\lambda_i HP_1 - U) \quad (14)$$

Similarly, the local equilibrium of the model can be obtained, which is a prerequisite for analyzing the stability of the model.

The analysis of the above two models shows that both small and medium-sized Internet education enterprises and banking groups have a tendency to imitate the choice of high-yield strategies and are resistant to corporate defaults in long-term evolutionary cooperation. Influenced by factors such as risk level and default probability, small and medium-sized Internet education enterprises are subject to a higher degree of financing constraints in the early stages of development, and the credit relationship can only be established when the success rate of investment projects of small and medium-sized Internet education enterprises reaches a certain level. Obviously, in the absence of sufficient external constraints, relying solely on the self-discipline of small and medium-sized Internet education enterprises and the supervision and punishment of banks, the game is difficult to reach an evolutionary steady state, and to a certain extent, the enterprise financing problem is still difficult to solve.

Therefore, under such a situation, on the one hand, on the basis of constantly improving and improving the external environment of financing for small and medium-sized Internet education enterprises, enhance their risk resistance ability and strengthen the bank's financial support for small and medium-sized Internet education enterprises in the process of development. On the other hand, it is necessary to expand the financing channels of small and medium-sized Internet education enterprises as much as possible, attract diversified investment bodies to enter the credit system, so as to form a diversified financing system, which is also an important premise and foundation for this paper to build an open financing model for small and medium-sized Internet education enterprises.

3.2 Stabilization Strategies for Evolutionary Games

The replicator dynamics models of Models I and II give the general tendencies of the choice mechanism of groups E and B and the local equilibrium locations where the stability of the credit behavior of the financing parties can be achieved. The discussion of the evolutionary stability of these equilibrium points can further lead to the set of strategies that groups E and B ultimately choose during the game, and the ability of these strategies to protect themselves against the intrusion of other strategies in the face of the mutation mechanism.

3.2.1 Evolutionary Stability Analysis of Model I

In general, this strategy is implemented when the bank can only consider approving a loan if the firm's guarantee is greater than the bank's cost of funds DR_0 . At this point, P1={λi[D(1+R(t))-G]+G-DR0}/λi[D(1+R(t))-G] takes values outside the (0, 1) interval and is therefore no longer part of the local equilibrium.

Based on the assumptions given by the theoretical model, the replicated dynamic model of Model I can be simplified as follows.

$$\dot{P} = P_1(1 - P_1)Q_1X \tag{15}$$

$$\dot{Q} = Q_1(1 - Q_1)Q_1(Y - P_1Z) \tag{16}$$

where X, Y and Z are all greater than 0 and real. These two equations approximate the standard replicator dynamics of the multiple aggregate entry obstruction game, it can be concluded

that, P_1 decreasing single point along the inner point solution orbit on the plane (0, 1), Q_1 instead, it shows a U-shaped trend of decreasing and then increasing. P_1, Q_1 is an asymptotically stable strict Nash equilibrium. In the initial state due to P_1 is in a high level, that is, small and medium-sized Internet education enterprise group in the early stage of entrepreneurship due to the success rate of the project must face great risks, the default rate of enterprises will be higher, resulting in the bank's approval rate of the loan application of this type of enterprise will be significantly reduced, and the non-loan strategy will be its choice. When the P_1 value becomes smaller and smaller and finally reaches 0, it means that the group of small and medium-sized Internet education enterprises in the game party has found that the enterprises that repay the loan on time can get higher income in the long-term development in the course of repeated games, so the enterprises that initially chose to default begin to imitate the enterprises with high credit rating to choose the strategy of repaying the loan on time. At the same time, in the process of continuous development, the business situation and R&D level of the enterprise after the start-up period and early growth period tend to stabilize, and the success rate of the project gradually improves, and the objective default rate of the enterprise will also gradually decrease. As a result, the default rate of the group of small and medium-sized Internet education enterprises will eventually drop to zero, and all enterprises will choose the strategy of repayment on schedule and gradually achieve stability. It is worth noting that due to the low threshold of enterprise establishment in China and the average life expectancy of only 2.9 years, most of the enterprises in this group actually have difficulty in overcoming the "peak of death" during the start-up period, and the default rate will not be able to reach the ideal state in Model I for a long time, and the financial constraints of the whole group will inevitably be further increased, which will lead to some enterprises with real potential for cultivation and support. As a result, some small and medium-sized Internet education enterprises with real potential for cultivation and support will also be unable to receive effective financial support from banks.

3.2.2 Evolutionary Stability Analysis of Model II

Although Model I incorporates a requirement for collateralized guarantees while taking into account the firm's innovation risk, banks are still unable to guarantee that firms will repay on time under conditions of asymmetric information. In addition, the rationing of collateralized and guaranteed lending mainly excludes firms that are unable to meet the collateral and guarantee thresholds, and since not all of these firms are high-risk borrowers, this type of lending may provide security to the bank but at the same time result in a greater loss of potential economic returns. Therefore, in Model II, regulatory and incentive/penalty mechanisms are designed to achieve effective screening of risk information and to incentivize firms to improve project success. According to the replicator dynamics

equation of Model II, it can be concluded that the values of the reward and penalty amount H and the regulatory cost U are directly related to the final evolutionary stability of the model.

From the initial state of the bank to take regulatory incentives and penalties strategy, enterprises choose to repay on schedule, at this time because of the default rate of 0, the bank in order to reduce the cost of supervision gradually reduce the proportion of regulatory review. When part of the enterprise in the multiple game to observe the bank's strategy changes, began to choose to default on fraudulent loans in order to obtain higher returns, the whole process of default rate monotonically increasing. When P1 is greater than U/λiH, the bank forced by the pressure of non-performing loans have to re-increase the regulatory efforts, until all the establishment of regulatory incentives and penalties mechanism, in order to gradually achieve evolutionary stability.

In this model, small and medium-sized Internet education enterprises and banks do not form an evolutionary stable strategy combination. In this simulation of the evolutionary game process, due to the bank's rewards and punishments H larger, enterprises tend to choose to repay on time, when the bank gradually tends to adopt the strategy of not regulating the rewards and punishments, so the enterprise group in the pursuit of maximizing the benefits of "rational" individuals will inevitably increase the probability of default, so in the repeated cycle of the model will never So the model will never reach the point (0,0) under repeated cycles. This also fully demonstrates that the construction of stable credit relationships, in addition to the establishment of perfect supervision, reward and punishment mechanism, but also need the government, credit guarantee institutions and other external forces to join, so as to help promote the entire small and medium-sized Internet education enterprise financing system towards the development of stable state.

Both groups, small and medium-sized Internet education enterprises and banks, have a tendency to imitate high-yield strategies, but the group of small and medium-sized Internet education enterprises is resistant to the defaults of a few enterprises in the long-term evolutionary cooperation with banks; due to the positive correlation between the risk level, the probability of default and the proportion of bank loans, the small and medium-sized Internet education enterprises are subjected to the highest degree of financing constraints during the entrepreneurial period; In the absence of external power constraints, the game model cannot reach an evolutionary stable state by relying only on endogenous factors such as the sense of integrity of small and medium-sized Internet education enterprises and the regulatory mechanism of banks. Therefore, it is inevitable to introduce diversified capital providers to diversify and share the risks in lending to SMEs.

4. Evolutionary Game Analysis of Open Financing Models for Small and Medium-sized Internet Education Enterprises

According to the above analysis of the bank-enterprise evolutionary game, it can be seen that relying only on endogenous elements such as small and medium-sized Internet education enterprises and bank regulatory mechanisms, the evolutionary game model is difficult to reach an evolutionary stable state,

and external factors must be added. Therefore, in the following, we will construct a diversified open financing system, theoretically analyze the role of different types of subjects, and explore the evolutionary game process and strategy selection of small and medium-sized Internet education enterprises and other participants in the open financing model.

a) Multi-structural Analysis of Open financing Models

According to the co-evolution mechanism of banks and enterprises, the relationship between small and medium-sized Internet education enterprises and banks must be analyzed from the perspective of the overall credit financing environment. In the external financing environment in which they are located, small and medium-sized Internet education enterprises continuously exchange material, energy and information with the outside world to realize sustainable growth. Just like the ecological role and ecological adaptation between organisms and the environment, small and medium-sized Internet education enterprises and banks are continuously interacting and adapting to each other through the innovative adjustment of structure, process, function, and so on. In addition, other external forces also directly or indirectly affect or influence the credit relationship between banks and enterprises. Therefore, a complete open financing model should include three aspects: system component unit, system model and system ecological environment.

The system components are the basic units that form the open financing model and enable it to function properly. According to the theory of credit financing, the system component units mainly include banks, investors, non-bank financial institutions, small and medium-sized Internet education enterprises, government departments and credit guarantee institutions. According to the above analysis of the development of the open financing model, small and medium-sized Internet education enterprises and capital supply groups are the main participants of the open financing model, and other constituent units such as relevant government departments and credit guarantee institutions provide various kinds of financial, tax, legal and other policy support and credit guarantee services for the orderly operation of the open financing model. The system mode refers to the mode of operation and the form of combination among the system units of the open financing model, and also reflects the relationship between the intensity of operation and energy exchange among the system units. Analyzed from the perspective of financial symbiosis, the system mode can be divided into three categories: parasitic mode, one-sided symbiosis mode and mutual symbiosis mode, and the system mode keeps changing with the changes of the system unit and system environment of the open financing model. The external factors affecting the system unit and system mode constitute the external environment of the open financing model system. The system ecological environment has complexity and variability, generally through the change of environmental variables on the open financing model system component units and the role of relationship has an impact. The system ecological environment mainly includes the political environment, financial environment, regional cultural environment, etc., and the system unit will also affect the changes of the system environment in the process of actively adapting to its changes.

In the multifaceted structure of the open financing model system, the constituent units are the basis for the operation of the system, and they are connected with each other through information transmission and resource circulation to realize the orderly operation of the open financing model. The system model is the core of the open financing model, which reflects the interactive relationship and operation mode of the system units, and directly determines the survival status and development direction of the system units in the external environment. The ecological environment of the system is the external conditions for the development of the open financing model, which manifests the positive and negative effects of the positive and negative environment on the open financing model by stimulating and inhibiting the exchange of material, information and ability of each system unit. In the ecological environment of the open financing model, while each system unit exchanges with each other and with the environment to obtain the resources necessary for growth, each system unit must also return profits to the system unit at the level above it. Therefore, the financial support of diversified capital providers to small and medium-sized Internet education enterprises has become an important driving force for the orderly development of the whole open financing system, and also an important way to break through the limitations of the traditional bank-enterprise financing system and promote small and medium-sized Internet education enterprises to solve the financing difficulties.

Small and medium-sized Internet education enterprises, capital suppliers have both the basic economic characteristics of maximizing economic interests as the goal, but at the same time, they are also in a complex financial ecosystem, and their development has the evolutionary characteristics of self-adaptation, disequilibrium and dynamics. Therefore, in the financing ecosystem, small and medium-sized Internet education enterprises and capital providers, as the core participants of the open financing system, have a certain learning and imitation ability, and can choose and adjust their behavioral strategies according to the changes of all kinds of variables in the dynamic evolutionary game of pursuing their own interest maximization, and form a stable strategy that is suitable for the sustainable development of the financing system. At the same time, the government and other relevant departments use financial and fiscal policies, legal policies and related regulatory means to change the behavioral strategies of the participants to maximize the interests of the system, while credit guarantee institutions play an intermediary role between the capital provider and small and medium-sized Internet education enterprises to reduce the degree of information asymmetry of the participants, and promote the open financing model to achieve the development of a stable equilibrium.

b) Evolutionary Game Analysis of Open Financing Models

i. Analysis of Multiple Relationships in Open Financing Models

In the process of development, small and medium-sized Internet education enterprises must continuously exchange material, energy and information with the external environment to realize sustainable development. Like living organisms, the behavior of small and medium-sized Internet education enterprises is essentially the result of ecological action and ecological adaptation. Therefore, in the open financing system of small and medium-sized Internet education enterprises, it includes the

constituent elements of the system, the structure of the system, and the system environment. Among them, the constituent elements of the system are the basic constituent units for the open financing system of small and medium-sized Internet education enterprises to keep functioning, and according to the previous analysis of this paper, the constituent units should include small and medium-sized Internet education enterprises, banks, governments, intermediary institutions, non-banking financial institutions, investing individuals and so on. The structure within the system is the way of the role and connection between each different constituent body, and at the same time reflects the strength of the relationship between different units. In addition, the factors influencing the relationships of the internal structure of the system constitute the external environment of the open financing system. In fact, the influencing factors in the financing process are numerous and complex, and will produce diversified role relations on the constituent subjects of the system. Generally speaking, the external environment is mainly the political environment, financial environment and cultural environment.

In the open financing system of small and medium-sized Internet education enterprises, the various constituent subjects are the basis for the orderly operation of the system, and the various subjects are connected with each other through the transmission of financial information and the exchange of resources. The internal structure of the system is the key to network financing, because it reflects the interaction relationship and operation mode between different subjects, and has an important influence on the development and stability of the system. On the other hand, the external environment is an important external condition for the development of the open financing system, and this external influence may have a positive or negative effect. In the open financing system of small and medium-sized Internet education enterprises, when the interaction between different subjects and the environment occurs, there will also be corresponding benefits fed back to the upper level of the constituent units at the same time. Therefore, in the process of network financing, if the small and medium-sized Internet education enterprises get the support of credit funds for development, especially some supporting funds, it will help to arouse the enthusiasm of other investment subjects in the whole system, so as to inject the momentum of stable development into this open financing system.

Small and medium-sized Internet education enterprises and other subjects participating in the open financing system have the motive of profit maximization, which is one of the common characteristics of these subjects. At the same time, they are located in a unified financial ecosystem system. Therefore, in the open financing system, different subjects have a certain learning ability, are motivated to seek those strategies that help maximize their own interests, and can take the initiative to adjust their strategies according to the changes in the external environment, so as to form a stable strategy for the stable operation of the whole system. At the same time, the relevant national or local policy regulation, to a certain extent, can change the behavior of participating subjects, help to maximize the interests of the system, credit guarantee and other intermediary structures in the small and medium-sized Internet education enterprises open financing system plays an effective role in the intermediary information transfer, to a certain extent, help to reduce the degree of information asymmetry, and then promote the

whole open financing system to achieve the evolutionary stability equilibrium. Evolutionary stable equilibrium state.

ii. Game Model Analysis of Open Financing Models for Small and Medium-sized Internet Education Enterprises

In the financing system of small and medium-sized Internet education enterprises, the government plays the role of policy maker and regulator, which has a very important influence on the operation of the whole system. The development of small and medium-sized Internet education enterprises has a high degree of uncertainty and risk, and in the process of their financing, various investment subjects are often reluctant to invest their funds in small and medium-sized Internet education enterprises, taking into account factors such as the safety of funds. In the open financing system, the main purpose is to diversify and release the risk through the diversification of participating subjects, so as to achieve the alleviation of the predicament of financing difficulties of small and medium-sized Internet education enterprises. Although risks can be diversified in the open-ended financing model, the supply side of funds will still take into account the impact of risks. Therefore, in such a situation, the government is required to play its leading role, on the one hand, through various fiscal and tax and other related policy support, to guide banks and other institutions to provide more credit funds for small and medium-sized Internet education enterprises; on the other hand, through the policy support funds, to attract more main body of funds to enter the open-ended financing system, to increase the total amount of capital supply in the market. Therefore, if the government does not provide supportive funds, the level of return that can be obtained is J. If the government provides a series of supportive funds for the development of small and medium-sized Internet education enterprises, it is bound to stimulate the enthusiasm of enterprises. At the same time, it will also attract more external funds to enter, which will help small and medium-sized Internet education enterprises to obtain funds for the development process, and the probability of success of the enterprises will be greatly increased, and thus the government will obtain an additional return ρ.

As an open financing platform, an intermediary such as a credit guarantee agency is also an essential part of an open financing system. Usually, the guarantee of a third-party guarantee institution is required in a network financing platform. Guarantee institutions fulfill the payment obligation on behalf of small and medium-sized Internet education enterprises in case of default through the network financing platform. Therefore, in this process, whether intermediary institutions such as guarantee institutions can establish a stable cooperative relationship with the platform party directly determines, to a certain extent, whether small and medium-sized Internet education enterprises can obtain the necessary financial support from the financing platform. Thanks to the government's participation in the open financing system, the credit financing environment for small and medium-sized Internet education enterprises has been improved, and the investment risk has been relatively reduced. At the same time, the government's support will make the default rate of small and medium-sized Internet education enterprises decrease, which will surely attract more capital supply main body to join. Thus,

on the basis of the above model I, taking into account the participation of the government, intermediaries, platforms and other subjects, the evolutionary game model III is constructed to obtain the adaptability function of small and medium-sized defaults and non-defaults:

$$f_1^E = Q_1\left\{\lambda_i\left[D\left(1+\kappa_i\right)+C_i-G-F\right]-BD-DIR_{DB}\right\} \tag{17}$$

$$f_2^E = Q_1\left\{\lambda_i\left[D\left(\kappa_i-R\left(t\right)\right)+C_i+F\right]-BD-DIR_{DB}\right\} \tag{18}$$

Based on the expected returns of each subject in the open financing system, the replicated dynamic model of the evolutionary game model III can be obtained:

$$\overset{\bullet}{P} = P_1(f_1^E - \overline{f^E}) = P_1(1-P_1)Q_1\lambda_i\left[D\left(1+R\left(t\right)\right)-G-2F\right] \tag{19}$$

$$\overset{\bullet}{Q} = Q_1(f_1^B - \overline{f^B}) = Q_1(1-Q_1)\left\{G+DIR_{1x}+F_B-DR_0+\lambda_i\left(1-P_1\right)\left[D\left(1+R\left(t\right)\right)-G-DIR_{1x}-F_B\right]\right\} \tag{20}$$

According to the analysis of the above model, it can be seen that the support of government policies plays a very important role in the open financing system to achieve the stable development state. When the role of policy is enhanced, the financial ecological environment of small and medium-sized Internet education enterprises will have a more obvious improvement, which will help small and medium-sized Internet education enterprises to obtain external financial support, so that the probability of success of small and medium-sized Internet education enterprises is enhanced, making the probability of repayment on schedule greatly improved, and promoting the evolution of the evolution into the stable state.

The loan repayment stage is further considered, i.e., model IV is constructed on the basis of model II above. The fitness functions for default and non-default of small and medium-sized Internet education enterprises are obtained:

$$f_1^E = \lambda_i\left[D\left(1+\kappa_i\right)+C_i-G-F\right]-BD-DIR_{DB}-V_1H \tag{21}$$

$$f_2^E = \lambda_i\left[D\left(\kappa_i-R\left(t\right)\right)+C_i+F\right]-BD-DIR_{DB}+V_1\left(2\lambda_iH-H\right) \tag{22}$$

Further computation yields a replicated dynamic model for Model IV:

$$\overset{\bullet}{P} = P_1(f_1^E - \overline{f^E}) = P_1(1-P_1)\left\{\lambda_i\left[D\left(1+R\left(t\right)\right)-G-2F\right]-2\lambda_iV_1H\right\} \tag{23}$$

$$\overset{\bullet}{V} = V_1(f_1^B - \overline{f^B}) = V_1(1-V_1)\left(DIR_{1x}+F_B\right)\left(1-\lambda_i+\lambda_iP_1\right) \tag{24}$$

When there is a higher level of government policy support, the implementation of relatively strict reward and punishment mechanisms by the capital provider or the implementation of reward and punishment mechanisms by the platform side, and small and medium-sized Internet education

enterprises choose to repay on schedule, the development of the open financing system stabilization strategy. In such a case, the role of intermediaries such as guarantees is not obvious.

5. Conclusion

The open financing mode of small and medium-sized Internet education enterprises is a combination of traditional financing mode and Internet financing mode, which can effectively solve the information asymmetry in the financing process, reduce the financing risk and improve the financing efficiency. The open financing model of small and medium-sized Internet education enterprises is a multi-subject participation system. Using the evolutionary game theory, the theoretical analysis and mathematical derivation of the open financing game process is carried out, and the conclusions of the study provide a reference for solving the financing constraints of small and medium-sized Internet education enterprises, which is conducive to promoting innovation and promoting the financing model of small and medium-sized Internet education enterprises.

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