ISSN: 2688-9323

Research on Multi-position Supervision Mode of Inventory Pledge Financing based on Evolutionary Game

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Abstract

Using the analysis method of evolutionary game theory, we explore the dynamic evolutionary game between financial institutions and financing enterprises under Multi-position supervision and single-position supervision in inventory pledge financing business, simulate the dynamic change process using MATLAB numerical simulation, and further analyze the influence of relevant parameters on financing decision. The research conclusion shows that: financial institutions can reduce financing risks through Multi-position linkage under Multi-position supervision mode, so they can reasonably set Multi-position supervision pledge rate and default margin, so as to increase financing revenue, and when financing enterprises keep the contract, the financing revenue of financial institutions must be higher than that of single-position supervision mode; secondly, financing enterprises can reduce the cost of replenishment, enhance financing through Multi-position linkage under Multi-position supervision mode The financial institutions can reasonably set the margin and Multi-position supervision pledge rate to avoid the default risk of the financing enterprises.

Keywords

Inventory Pledge Financing; Multi-position Supervision; Expected Return; Evolutionary Game.

1. Introduction

With the accelerating process of globalization, the competition among enterprises has been transformed into the competition among supply chains. However, SMEs in the supply chains generally have difficulties in financing, so inventory pledge financing business has emerged to provide solutions for SMEs' financing problems. Feng Kengzhong (2007)[1] points out that inventory pledge financing is a financing enterprise using its own inventory as collateral to secure loans from financial institutions under the agency supervision of a third-party logistics enterprise in order to obtain financing. Under the traditional model, the storage supervision enterprise will isolate the inventory of the financing enterprise, and then the financing enterprise will pledge the movable assets in different regions according to its own financing needs. However, this "one single warehouse" model, that is, a single warehouse in a single region for independent supervision and pledge mode, has been unable to meet the financing needs of financing enterprises in multiple regions and warehouses, on the one hand, financing enterprises need to repeat the pledge procedures, resulting in a waste of resources; on the other hand, financial institutions can not overall accounting of the same financing enterprise in different On the other hand, financial institutions are unable to account for the pledges of the same financing enterprise in different regions, and are unable to coordinate the value, interest rate and pledge rate of pledges in different regions.

The traditional single-warehouse pledge supervision mode ignores the impact of networked structure on the risk and return of inventory pledge financing, and based on joint pledge, an innovative mode and development trend of inventory pledge, this paper proposes to change the

ISSN: 2688-9323

situation of traditional segmented supervision through joint supervision of multiple warehouses. Under the multi-warehouse supervision model, the financing enterprise pledges its inventory in multiple warehouses in multiple regions to the same financial institution at one time and is supervised by the same third-party logistics enterprise, which effectively reduces the supervision cost and financing risk of the financial institution, reduces the replenishment cost of the financing enterprise, improves the capital utilization rate and financing revenue of the financing enterprise, and realizes a win-win situation for both the financial institution and the financing enterprise.

2. Literature Review

The inventory pledge financing model originated in the West; Klapper (2006) [2] studied the revenue problem of each participant in the inventory pledge financing business and optimized the financing model based on this; Buzacott (2004) [3] combined the inventory decision of financing firms and suggested that the financing revenue could be optimized by determining the optimal ordering decision; Raghavan et al. (2009) [4] found that borrowing firms tend to engage in inventory pledge financing. Earlier domestic research scholars have also studied inventory pledge financing models; Yu Yang and Feng Kengzhong (2003)[5] compared and analyzed two financing models: pledge of flowing goods and pledge of rights, and Li Yixue et al. (2007)[6] summarized the evolutionary process and mechanism of inventory pledge financing business at home and abroad.

In terms of risk management of inventory pledge financing business, Tian Hongying et al. (2018)[7] analyzed that banks can effectively control the financing risks of small and medium-sized borrowing enterprises by setting appropriate loan interest rates and pledge rates through a game model to induce them to invest in projects with less risk and more reasonable returns to achieve satisfactory borrowing performance rates; Han Gang et al. (2010)[8] studied the transformation of static pledge regulation into dynamic Laeequddin et al. (2012)[9] found through empirical research that mutual trust among financing subjects will reduce credit risk to a certain extent, thus enhancing the financing effect; Mou Xiaoli (2017)[10] argued that by building an inventory pledge financing service platform and clarifying the ownership of pledges, pledge rights and supervision rights, it can effectively reduce the moral risk and operational risk in the business.

Based on the endogenous condition of enterprise default, Jokivuolle et al. (2003)[11] established a pledge rate solution model and found that the pledge rate is inversely proportional to the fluctuation degree of pledge value and default probability; Cossin et al. (2003) [12] found that under the exogenous condition of enterprise default, the pledge rate decreases with the gradual increase of pledge time; Yi-Xue Li et al. (2007) respectively (2007) determined the pledge rate model when the end-of-period price of pledges obeyed the general distribution, lognormal distribution, normal distribution, and geometric Brownian law of motion; Yi, Xuehui et al. (2011) [13] found that the pledge rate and the bank's expected profit were positively related to the degree of repurchase guarantee of the core firms; Li, Fuchang et al. (2016) [14] found that the best quality pledge rate of commercial banks and the maximum expected profit were insensitive to the probability of default sensitive but very sensitive to the pledge yield; Li Fuchang et al. (2018) [15] studied the pledge rate decision of commercial banks by constructing a best quality pledge rate decision model.

In terms of regulatory management of inventory pledge financing business, Diercks (2004) [16] studied the implementation of effective supervision of pledges to reduce financing risks and increase financing returns; Ma Zhonghua et al. (2011) [17] argued that logistics enterprises need to provide regulatory services that meet certain conditions when participating in inventory pledge financing business; Ding Liying et al. (2014) [18] from a legal perspective, the

ISSN: 2688-9323

study the operation of pledge supervision business under different regulations; Zhou Ying (2016)[19] studied and designed the pre-lending access mechanism and post-lending supervision mechanism for banks' risk supervision of logistics enterprises under the unified credit model; Chu Xuejian et al. (2018)[20] proposed a two-dimensional code technology supervision scheme by analyzing the existing supervision mode of inventory pledge financing business.

In summary, the current research on inventory pledge financing mainly focuses on financing mode, risk management, pledge rate research, supervision, etc., but the supervision mainly focuses on single-position supervision, and lacks research on the joint supervision mode of multiple positions. Therefore, this paper analyzes the dynamic evolution game between financial institutions and financing enterprises in inventory pledge financing business under Multi-position supervision and single-position supervision mode, and discuss the influence of relevant parameters on financing decision, which provides a useful supplement to the research on Multi-position supervision mode of inventory pledge financing.

3. Evolutionary Game Model of Financial Institutions and Financing Firms

3.1. Model Assumptions

Hypothesis 1: The enterprises in the model are all finite rational and pursue the maximization of their own interests.

Hypothesis 2: The financing enterprises are SMEs, which can only obtain loans by pledging movable assets and do not have their own funds, and the financing yield is greater than the financing interest rate.

Hypothesis 3: The lending rate of financial institutions in inventory pledge financing business is fixed.

Hypothesis 4: The default risk of financing enterprises in inventory pledge financing business mainly comes from market price fluctuations or dynamic pledge mode causing the value of pledged goods to be lower than the warning value.

Assumption 5: The loan cycle in inventory pledge financing business is a single cycle, the initial value of goods in each warehouse is equal, and at the end of the period, the value of goods will be lower than the warning value due to inventory in and out of storage and market price fluctuations.

Hypothesis 6: Inventory pledge financing under multi-warehouse supervision mode means that the same financing enterprise pledges goods stored in multiple supervised warehouses to the same financial institution and designates the same logistics enterprise to supervise them on its behalf.

Hypothesis 7: Under multi-warehouse supervision mode, if the value of goods in the warehouse is lower than the warning value, the value of goods can be improved through multi-warehouse linkage; if the overall value of goods in multi-warehouses is lower than the warning value at the same point in time, all warehouses will be locked and closed.

3.2. Model Construction

In the inventory pledge financing business, the game decision of the financing enterprise is "default" and "keep the contract", that is, the financing enterprise can choose whether to return the principal and interest on time after the financing business expires; the game decision of the financial institution is "single warehouse Supervision" and "multi-warehouse supervision", that is, the financial institutions can choose the supervision mode of each warehouse alone or multi-warehouse joint supervision. The following definitions are made in the study.

ISSN: 2688-9323

r is the loan interest rate of financial institutions, ρ is the pledge rate under multi-warehouse supervision mode, α is the pledge rate coefficient of single-warehouse supervision relative to multi-warehouse supervision, then the pledge rate of single-warehouse supervision is αρ, γ is the warning value, the average supervision cost of financial institutions under multi-warehouse and single-warehouse supervision modes are J_1, J_2, and J_1<J_2, and C is the closing cost of financial institutions after the default of financing enterprises.

The financing enterprise uniformly pledges the goods of n warehouses, V_0 is the initial pledged goods value of each warehouse, and the ending goods value is V_1, V_2, and V_1≥V_2 under multi-warehouse and single-warehouse supervision mode respectively, and V_1≥V_2, γV_0≥V_1 and γV_0≥V_2 when the financing enterprise defaults, and the average payment of default margin W_1 under multi-warehouse supervision mode, and W_2 under single-warehouse supervision, and W_1<W_2, F is the default penalty cost. The rate of return obtained by the financing enterprise using the single-position loan amount for operation is R. The average cost of replenishment under the Multi-position supervision model is B_1, and the cost of replenishment under the single-position supervision is B_2.

In summary, the revenue matrix of the game between financial institutions and financing enterprises is shown in Table 1.

Table 1. The payoff matrix of the game between financial institutions and financing firms

		Financing companies	
		Keep the promise	Default
Financial Institution	Multi-position Regulation	$\rho V_0 r - J_1$ $\rho V_0(R-r) - B_1$	$V_1 - \rho V_0 - J_1 - C + W_1$ $\rho V_0(1+R) - V_1 - W_1 - F - B_1$
	Single position Regulation	$\alpha\rho V_0 r - J_2$ $\alpha\rho V_0(R-r) - B_2$	$V_2 - \alpha\rho V_0 - J_2 - C + W_2$ $\alpha\rho V_0(1+R) - V_2 - W_2 - F - B_2$

3.3. Model Analysis

Suppose the probability of financial institutions choosing Multi-position regulation is x, then the probability of choosing single-position regulation is $1-x$; the probability of financing enterprises defaulting is y, then the probability of their keeping the contract is $1-y$.

3.3.1. Replication Dynamic Equations of Financial Institutions and Their Evolutionary Stabilization Strategies

The average expected return per position of the financial institution under the Multi-position regulation model is

$$E_{\text{multi}} = y(V_1 - \rho V_0 - J_1 - C + W_1) + (1-y)(\rho V_0 r - J_1) \tag{1}$$

The expected return for financial institutions under the single position regulation model is

$$E_{\text{single}} = y(V_2 - \alpha\rho V_0 - J_2 - C + W_2) + (1-y)(\alpha\rho V_0 r - J_2) \tag{2}$$

Let $E_{\text{multi}} = E_{\text{single}}$, Then the probability of default of the financing firm is

$$y_0 = \frac{J_2 - J_1 + \rho V_0 r(1-\alpha)}{W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)} \tag{3}$$

Therefore, the average expected return for financial institutions is

ISSN: 2688-9323

$$\overline{E_F} = xE_{multi} + (1-x)E_{\text{single}} = x\{y[V_1 - V_2 + W_1 - W_2 + \rho V_0(1+r)(\alpha-1)] + J_2 - J_1 + \rho V_0 r(1-\alpha)\} + y(V_2 - \alpha\rho V_0 - \alpha\rho V_0 r - C + W_2) + \alpha\rho V_0 r - J_2 \quad (4)$$

Substituting into equation (4), the replication dynamic equation for financial institutions.

$$F(x) = \frac{dx}{dt} = x(E_{\text{multi}} - \overline{E_F}) = x(1-x)\{y[V_1 - V_2 + W_1 - W_2 + \rho V_0(1+r)(\alpha-1)] + J_2 - J_1 + \rho V_0 r(1-\alpha)\} \quad (5)$$

To replicate the dynamic equation for Eq. (5) for the derivative.

$$F'(x) = (1-2x)\{y[V_1 - V_2 + W_1 - W_2 + \rho V_0(1+r)(\alpha-1)] + J_2 - J_1 + \rho V_0 r(1-\alpha)\} \quad (6)$$

Let F(x)=0, this paper find that x^*=0 and x^*=1 are the two stable states of x (y≠y_0).

3.3.2. The Replication Dynamic Equation of the Financing Firm and its Evolutionary Stabilization Strategy

The expected return when the financing firm defaults is

$$E_{\text{default}} = x[\rho V_0(1+R) - V_1 - W_1 - F - B_1] + (1-x)[\alpha\rho V_0(1+R) - V_2 - W_2 - F - B_2] \quad (7)$$

The expected return when the financing firm keeps its contract is

$$E_{\text{keep}} = x[\rho V_0(R-r) - B_1] + (1-x)[\alpha\rho V_0(R-r) - B_2] \quad (8)$$

Let $E_{\text{default}} = E_{\text{keep}}$, The probability of obtaining a Multi-position regulation of a financial institution is

$$x_0 = \frac{V_2 + W_2 + F - \alpha\rho V_0(1+r)}{W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)} \quad (9)$$

Therefore, the average expected return of the financing firms is

$$\overline{E_f} = yE_{\text{default}} + (1-y)E_{\text{keep}} = y\{x[V_2 - V_1 + W_2 - W_1 + \rho V_0(1+r)(1-\alpha)] + \alpha\rho V_0(1+r) - V_2 - F - W_2\} + x[\rho V_0(R-r)(1-\alpha) + B_2 - B_1] + \alpha\rho V_0(R-r) - B_2 \quad (10)$$

Substituting into equation (10), the replication dynamic equation of the financing firm.

$$F(y) = \frac{dy}{dt} = y(E_{\text{default}} - \overline{E_f}) = y(1-y)\{x[V_2 - V_1 + W_2 - W_1 + \rho V_0(1+r)(1-\alpha)] + \alpha\rho V_0(1+r) - V_2 - F - W_2\} \quad (11)$$

To replicate the dynamic equation for Eq. (11) for the derivative.

$$F'(y) = (1-2y)\{x[V_2 - V_1 + W_2 - W_1 + \rho V_0(1+r)(1-\alpha)] + \alpha\rho V_0(1+r) - V_2 - F - W_2\} \quad (12)$$

ISSN: 2688-9323

Let$F(y) = 0, y^* = 0$and$y^* = 1$ are the two stable states of y ($x \neq x_0$).

3.4. Stability Analysis

According to the above game model of financial institutions and financing enterprises, it is known that there are five equilibrium points in the game process for inventory pledge financing business: (0,0), (0,1), (1,0), (1,1), (1,1), (x_0, y_0). Where (x_0, y_0) satisfies $0 \leq x_0 \leq 1$ with $0 \leq y_0 \leq 1$,that is $0 \leq V_2 + W_2 + F - \alpha\rho V_0(1+r) \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha), J_2 - J_1 \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$. The stability of the above equilibrium point is judged using the Jacobi matrix. If the determinant Det of this matrix is positive and the trace Tr is negative, the point is asymptotically stable; if the determinant Det and the trace Tr of this matrix are both positive, the point is unstable; if Det is positive and Tr is zero, the point is central; if Det is negative, the point is a target point.

Table 2. Stability analysis

			(0,0)	(0,1)	(1,0)	(1,1)	(x_0, y_0)
Case 1	$0 \leq V_2 + W_2 + F - \alpha\rho V_0(1+r) \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)$, $J_2 - J_1 \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	-	-	-	-	+
		Tr	indeterminate	indeterminate	indeterminate	indeterminate	0
		stability	Target point	Target point	Target point	Target point	Center point
Case 2	$0 \leq V_2 + W_2 + F - \alpha\rho V_0(1+r) \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)$, $J_2 - J_1 \geq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	-	+	-	+	
		Tr	indeterminate	+	indeterminate	-	
		stability	Target point	The instability point	Target point	Progressive stabilization point	
Case 3	$V_2 + W_2 + F - \alpha\rho V_0(1+r) < 0$, $J_2 - J_1 \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	+	+	-	-	
		Tr	+	-	indeterminate	indeterminate	
		stability	The instability point	Progressive stabilization point	Target point	Target point	
Case 4	$V_2 + W_2 + F - \alpha\rho V_0(1+r) < 0$, $J_2 - J_1 \geq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	+	-	-	+	
		Tr	+	indeterminate	indeterminate	-	
		stability	The instability point	Target point	Target point	Progressive stabilization point	
Case 5	$V_2 + W_2 + F - \alpha\rho V_0(1+r) > W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)$ $J_2 - J_1 \leq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	-	-	+	+	
		Tr	indeterminate	indeterminate	-	+	
		stability	Target point	Target point	Progressive stabilization point	The instability point	
Case 6	$V_2 + W_2 + F - \alpha\rho V_0(1+r) > W_2 - W_1 + V_2 - V_1 + \rho V_0(1+r)(1-\alpha)$, $J_2 - J_1 \geq W_2 - W_1 + V_2 - V_1 + \rho V_0(1-\alpha)$	Det	-	+	+	-	
		Tr	indeterminate	+	-	indeterminate	
		stability	Target point	The instability point	Progressive stabilization point	Target point	

According to Eq. (5) and Eq. (11), the Jacobi matrix of the system can be derived as follows.

ISSN: 2688-9323

$$J = \begin{vmatrix} \frac{\partial\left(\frac{dx}{dt}\right)}{\partial x} & \frac{\partial\left(\frac{dx}{dt}\right)}{\partial y} \\ \frac{\partial\left(\frac{dy}{dt}\right)}{\partial x} & \frac{\partial\left(\frac{dy}{dt}\right)}{\partial y} \end{vmatrix} = \begin{vmatrix} (1-2x)(E_{mul}-E_{sin}) & x(1-x)[\Delta V+\Delta W-Z] \\ y(1-y)[Z\rho V_0(1+r)(1-\alpha)-\Delta V-\Delta W] & (1-2y)(E_{de}-E_{keep}) \end{vmatrix} \quad (13)$$

$(\Delta V = V_1 - V_2; \Delta W = W_1 - W_2; Z = \rho V_0(1+r)(1-\alpha)$

The stability analysis is shown in Table 2.

In case 1, the gain of choosing to keep the contract under the Multi-position regulation model is smaller than the gain of default for financing firms, and the gain of choosing to keep the contract under the single-position regulation model is larger than the gain of default for financing firms; financial institutions prefer the single-position regulation model when financing firms default and the Multi-position regulation model when financing firms keep the contract. Therefore, there is no evolutionary stabilization strategy.

In case 2, the gain of financial institutions in Multi-position regulation mode is always greater than the gain of single-position regulation, and after evolution, the gain of financing enterprises choosing to default in Multi-position regulation mode is greater than the gain of keeping the contract. The stability point between financial institutions and financing firms is (1,1), i.e., financial institutions eventually choose the Multi-position regulation model and financing firms choose to default.

In case 3, the financing enterprise always tends to default, and the gain of the financial institution choosing the single-position regulation mode in the case of default of the financing enterprise is greater than the gain of Multi-position regulation. The stability point between financial institutions and financing enterprises is (0,1), i.e., financial institutions eventually choose the single-position supervision mode and financing enterprises choose to default.

In case 4, the gain of financial institutions in Multi-position regulation mode is always greater than the gain of single-position regulation, and the gain of financing enterprises choosing to default is always greater than the gain of keeping the contract. The stability point between the financial institution and the financing firm is (1,1), i.e., the financial institution eventually chooses the Multi-position regulation model and the financing firm chooses to default.

In case 5, the gain of the financing enterprise choosing to keep the contract is always greater than the gain of default, and the gain of the financial institution choosing the Multi-position supervision mode when the financing enterprise keeps the contract is greater than the gain of single-position supervision. The stability point between financial institutions and financing firms is (1,0), i.e., financial institutions eventually choose Multi-position supervision mode and financing firms choose to keep their contracts.

In case 6, the gain of financial institutions in Multi-position regulation mode is always greater than the gain of single-position regulation, and the gain of financing enterprises when they choose to keep the contract is always greater than the gain when they default. The stability point between financial institutions and financing firms is (1,0), i.e., financial institutions eventually choose the Multi-position regulation mode and financing firms choose to keep the contract.

In summary, the pledge rate of financial institutions, the cost of regulation, the cost of default margin and pledges of financing enterprises, and the penalty cost of default all affect the dynamic equilibrium decision of the game between financial institutions and financing enterprises. When the financing enterprise chooses to keep the contract, the financial institution has a higher return in the Multi-position regulation mode; when the financing enterprise has credit risk and J_2-J_1≥W_2-W_1+V_2-V_1+ρV_0 (1-α), the financial institution has a higher return in Multi-position regulation; when W_1+V_1+F>ρV_0 (1+r), the financing enterprise has a higher return in keeping the contrheact. Trefore, as long as the financial

ISSN: 2688-9323

institutions reasonably set the pledge rate and margin for Multi-position regulation, they will prefer the Multi-position regulation model, and the financing enterprises will tend to keep their contracts.

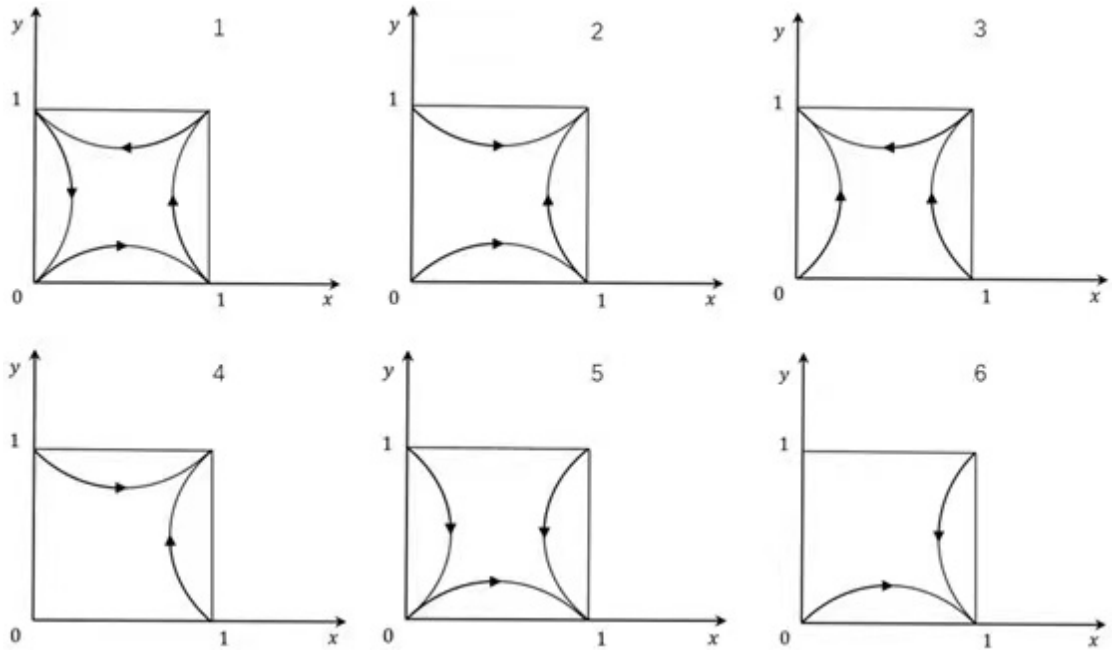

Figure 1. Dynamic evolutionary game between financial institutions and financing firms under different circumstances

4. Numerical Analysis of Stability

Based on the evolutionary game model of financial institutions and financing enterprises and the real situation, the relevant parameters are assigned and MATLAB is used to analyze the process of the evolutionary game in six contexts.

Table 3. Evolutionary game model parameter assignment

	V_0	V_1	V_2	r	R	ρ	α	J_1	J_2	W_1	W_2	F	C
Assignment1	10000	7000	6500	6%	10%	76%	90%	400	600	300	800	500	100
Assignment2	10000	7000	6500	6%	10%	74%	95%	200	600	300	600	500	100
Assignment3	10000	7000	6500	6%	10%	76%	93%	400	600	200	400	500	100
Assignment4	10000	7000	6500	6%	10%	74%	95%	200	600	200	300	500	100
Assignment5	10000	7000	6500	6%	10%	70%	90%	400	600	400	800	500	100
Assignment6	10000	7000	6500	6%	10%	70%	92%	200	600	400	600	500	100

The dynamic equilibrium between financial institutions and financing enterprises in the evolutionary game model is investigated by studying the dynamic changes of the probability x of choosing Multi-position regulation mode by financial institutions, the probability y of default by financing enterprises and the time t. The values of x and y are assumed to be 0.2, 0.4, 0.6, 0.8 and 1, respectively, and Matlab is used to simulate the six scenarios in Table 3, and the equilibrium is reached when x and y tend to a certain value over time. The evolution of the simulation under different assignment scenarios is shown in Figure 2.

In the case of assignment 1, the probabilities of x and y fluctuate between (0,1) and do not converge to a certain value, i.e., there is no equilibrium in the evolutionary game. In case of assignment 2, x and y tend to 1, i.e. to the equilibrium point (1,1), the financial institution chooses Multi-position regulation mode and the financing enterprise chooses to default, which

ISSN: 2688-9323

is consistent with case 2 of stability analysis. in case of assignment 3, x tends to 0 and y tends to 1, i.e. to the equilibrium point (0,1), the financial institution chooses single-position regulation mode and the financing enterprise chooses to default, which is consistent with case 3 of stability analysis. In case of assignment 4, x and y tend to 1, i.e., tend to the equilibrium point (1,1), the financial institution chooses Multi-position supervision mode and the financing enterprise chooses to default, which is consistent with the stability analysis of case 4. In case of assignment 5, x tends to 1 and y tends to 0, i.e., tend to the equilibrium point (1,0), the financial institution chooses Multi-position supervision mode and the financing enterprise chooses to keep the contract, which is consistent with the stability analysis of case 5. In the case of assignment 6, x tends to 1 and y tends to 0, i.e., tends to the equilibrium point (1,0), the financial institution chooses the Multi-position regulation mode and the financing enterprise chooses to keep the contract, which is consistent with the case 6 of stability analysis.

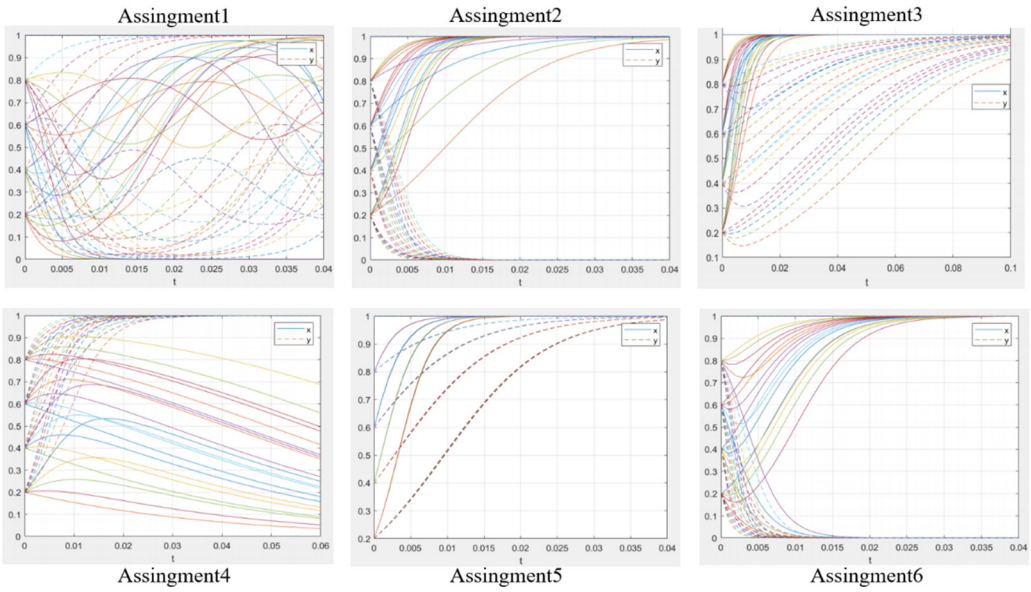

Figure 2. Simulation evolution under different assignment scenarios

According to the data simulation results, it can be found that different assignments to the parameters significantly affect the stability state of the evolutionary game. In the cases of assignment 2, 4, 5 and 6, x gradually tends to 1, i.e., the financial institutions have higher returns in the Multi-position regulation mode compared with the single-position regulation mode; in the cases of assignment 5 and 6, y gradually tends to 0, i.e., the returns of the financing enterprises' compliance are higher than the returns of default, so the financial institutions can effectively avoid the risk under the condition of $W_1 + V_1 + F > \rho V_0(1 + r)$.

5. Conclusions and Recommendations

Based on the evolutionary game between financial institutions and financing enterprises, this paper analyzes the revenue of inventory pledge financing business under Multi-position supervision mode and draws the following conclusions: First, financial institutions can reduce financing risks through Multi-position linkage under Multi-position supervision mode, so they can reasonably set Multi-position supervision pledge rate and default margin to ensure that the reduction value of Multi-position supervision relative to the cost of single-position supervision is greater than the difference of default margin and Secondly, the financing enterprise can reduce the cost of replenishment, enhance the leverage effect of financing and increase the liquidity through Multi-position linkage under Multi-position supervision mode, so the

ISSN: 2688-9323

financing enterprise has enhanced the initiative of repayment, and the financial institution can reasonably set the margin and Multi-position supervision. The financial institutions can reasonably set the margin and the pledge rate of Multi-position supervision to avoid the default risk of financing enterprises, so as to achieve a win-win situation for both financial institutions and financing enterprises and enhance the financing revenue and enthusiasm.

This paper analyzes the dynamic evolution of the game between financial institutions and financing enterprises in the inventory pledge financing business under Multi-position supervision and single-position supervision mode, and discusses the influence of relevant parameters on financing decisions, which provides a useful supplement to the research on the supervision mode of inventory pledge financing business, but there are still many shortcomings that need further research. Firstly, this paper mainly studies the improvement of Multi-position supervision relative to single-position supervision in terms of revenue, and the next step can be to study the impact of Multi-position supervision mode itself on the revenue of financial institutions and financing enterprises; secondly, there may be the risk of simultaneous explosion of multiple positions and internal supervision and theft under Multi-position supervision mode, and the risk management of Multi-position supervision system can be discussed in depth in the next step.

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