

Research on Credit Risk of Logistics Finance Based on Four-party Game Model

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Abstract: In the context of the Covid pandemic, which has a significant impact on the global economy and has brought more attention to the improvement and operation of the economic and financial system, the logistics industry is facing great challenges in this pandemic, and in this context, the concept of logistics finance is more well-known. Logistics finance business has been carried out rapidly because of its ability to effectively solve the problem of difficult capital turnover and financing for SMEs. In recent years, the government has introduced a series of economic incentives, logistics finance has played a deep role in regulating the flow of funds and improving the efficiency of capital operation, building a bridge connecting banks, logistics enterprises and financing enterprises to cooperate closely and achieving the goal of win-win situation for all parties. Although logistics finance plays an important role in the process of enterprise financing and generates significant benefits, it also faces potential risks in the process of development, so the establishment of logistics finance risk prevention system has become an urgent requirement for the sustainable development of logistics enterprises, banks and financing enterprises. Based on the full analysis of credit risk in logistics finance, this paper establishes a game model among logistics finance participants to find out various factors affecting the risk and provide a theoretical basis for the control of risk.

Keywords: Logistics finance, Credit risk, Game analysis.

1. Introduction

With the new crown epidemic sweeping the world in 2020, which has had a profound impact on global economic development and continues to do so, the logistics industry is facing huge challenges in this pandemic, and in this context, the concept of logistics finance is more familiar. Logistics finance has an early origin, from the grain warehouse receipts (Mesopotamia) and silver mine warehouse receipts (UK) in 2400 B.C., which are the earliest integration of logistics and finance; the grain mortgage (Tsarist Russia) in the early 20th century is the prototype of logistics finance. By analyzing rural finance, Omumah (2003) argues that the warehouse receipt system can not only improve farmers' income, but also allow agricultural products to be used as collateral for bank loans [1]. David Biederman (2004) discusses the warehouse receipt pledge financing business of logistics finance from three subjects: financial institutions, financiers and logistics enterprises. [2]; Yin Y & Luo Z (2009) study the assessment methods of logistics finance risks and identify and analyze the risks of logistics finance business. [3]; Sutopo (2011) (2011): Farmers can increase bank loans through warehouse receipt pledges and reduce the loss of agricultural products that are not sold. [4]; Hu Y, Xu HL (2013): Game theory is used to analyze the "land-financing warehouse" model and systematically analyze the "land-financing warehouse" model of rural logistics finance. The game theory is used to systematically analyze the cooperative game with incomplete information of all interested parties in rural logistics finance. [5]; Zhao Bo (2017) elaborates the factors that restrict the development of agricultural logistics by SMEs and the causes of logistics finance, and uses game theory to analyze the credit risk of SMEs in the development of agricultural logistics finance, so as to provide credit risk management suggestions for SMEs

in the process of developing agricultural logistics finance. [6]; Liu Xiaoli (2019) takes the logistics finance inventory pledge model as the research object, analyzed the game relationship among the subjects of financial institutions, financing enterprises and logistics enterprises through game theory, identified the elements that affect the smooth implementation of the pledge financing model, and proposed means and methods to prevent the occurrence of inventory pledge financing risks. Research on the risk of logistics finance [7]; Wright (1988) studied the role of third-party logistics enterprises in the operational aspects of logistics finance for risk reduction, mainly including the possibility of stricter monitoring of goods, stronger enforcement, and the timeliness of industry dynamics can lead to greater sensitivity to price fluctuations [8]; Frye (2000) pointed out that the traditional credit model, which tends to ignore the large economic This brings ideas for the authors to study the risk of pledges. [9]; Coulter and Onumah (2002), one of the risks of loan financing with pledges is price volatility, and discuss how to ensure the smooth operation of pledge loan business when the price of pledges fluctuates in developing countries and credit markets. [10]; Barsky (2005), analyzes the risk evaluation model of each major risk model of logistics finance. Barsky (2005) analyzed a risk evaluation model for each of the major risk models in logistics finance, including operational processes, macro environment, organizational structure, personnel, and information technology. This result laid the foundation for later studies on logistics finance risk, and also provided a reference for the collection of indicators for the risk evaluation index system in this paper [11]; Bo Yang proposed a logistics finance risk ontology, and he constructed a logistics finance related financial risk ontology model in order to make the risk controlled in many aspects, in order to adapt to the uncertain changes in the risk prediction process [12]; Wu Jun (2021) used the decision tree algorithm

in machine learning and applied the method to the logistics finance risk indicator system. The operation results obtained were observed, and the method was applied to effectively classify logistics finance risks[13] ; Lei Zhang (2021) identified risk evaluation indicators of the vicarious settlement model based on literature review, screened the indicators by expert scoring of Delphi method, and then constructed the risk evaluation indicator system[14] ; Lianxiang Zheng (2021) used hierarchical analysis and AHP entropy weighting method to combine and assign weights to indicators, and applied fuzzy comprehensive evaluation method to make a comprehensive evaluation of logistics financial risks to help logistics enterprises prevent risks from a comprehensive perspective[15] .

From the available research results, these studies focus on the risks of financial institutions, with little research on the risks of financing enterprises, logistics enterprises and government participation in logistics finance. Logistics enterprises as the link between financing enterprises and banks, not only to bear the risk of enterprise financing, but also to share the risk of banks, as well as in the case of government implementation of incentive policies, banks in logistics finance activities supervision, then how to identify these financial risks of logistics enterprises, how to control financial risks? This paper uses game theory knowledge to establish a four-party game model of relevant interest subjects and tries to analyze the risk strategy between logistics enterprises and banks, financing enterprises, banks and the government, in order to provide reference for relevant interest subjects in participating in logistics finance business to effectively avoid risks.

2. Basic Theory

Logistics finance refers to the innovative business model of joint cooperation and mutual development between logistics industry and financial field, i.e. the general term of investment and financing activities in the process of logistics operation, which means that financial institutions (banking industry) develop and apply various financial products by integrating logistics, commercial flow, capital flow and information flow in all aspects of logistics operation, and effectively organize and transfer the deposit and loan, mortgage, investment, lease, insurance and The logistics industry is involved in the intermediary business and other monetary capital movements. Logistics finance risk has both similarities and differences with general financial business risk. It refers to the economic loss caused by some uncertainty under the condition of integrated operation of logistics business combined with financial innovation. Due to the uncertainty of economic market activities, the combination of factors may have an impact on the smooth operation of logistics finance business, thus causing risk losses for logistics finance business in many aspects. Logistics finance combines many characteristics of logistics transportation and financial business, which also hides the risks brought by external parties in various aspects. Since the logistics finance business process and the relationship between the participants are to a certain extent complex, the external risks of logistics finance can be analyzed according to the business to affect the financiers, logistics enterprises, financial institutions and other subjects. Because of uncertainties such as the economic environment, it also further magnifies the external risk.

Therefore, how to assess the credit level of customers is also a serious challenge for logistics enterprises. In addition,

in the logistics finance business, logistics enterprises play the role of guarantee: when the customer cannot repay the loan on time and the value of the pledge is still unable to repay the loan principal and interest, logistics enterprises act as both the agent of the bank and the customer of the financing enterprise, and some of the bank risks are transferred to logistics enterprises, which makes logistics enterprises face many risks. This makes logistics enterprises participate in logistics financing not only to consider the financial credit status and operating status of the financing enterprise, but also to consider the risk mechanism of the bank.

3. Game Model Setting and Establishment

In order to model the quadratic behavior game using the relevant game theory, some basic assumptions should be defined as follows.

Assume the following probability distribution in the case of incomplete information and insufficient information exchange: the participants of the game model include banks, logistics companies and financing companies. The range of actions of the game participants includes.

H1: The probability that the bank will supervise is β_1 , the probability that the bank does not supervise is $1 - \beta_1$.

H2: The probability that the financing firm keeps the contract is β_2 , and the probability of non-compliance is $1 - \beta_2$ refuses the loan.

H3: The probability that the logistics company will keep the contract is β_3 , the probability of default will be $1 - \beta_3$.

H4: The probability of government incentive is β_4 and the probability that the bank does not supervise is $1 - \beta_4$.

H5: The cost for the financing firm to keep the contract is U_e^1 and the benefit is R_e^1 and the cost of non-compliance for the financing firm is U_e^2 ($U_e^1 > U_e^2$), and the benefit is R_e^2 ($R_e^2 > R_e^1$); the gain from default conspiracy is E, and the total gain is R_e

H6: Logistics companies keep their contracts with a gain of U_w^1 , the benefit is R_w^1 , the cost of non-compliance for the logistics enterprise is U_w^2 , ($U_w^1 > U_w^2$), the benefit is R_w^2 , ($R_w^2 > R_w^1$); Default income W, and the total gain is R_w

H7: The operational cost of supervision by the bank is U_b^1 and the benefit is R_b^1 The cost of operations without bank supervision is U_b^2 and the benefit is R_b^2 , and $R_b^1 > R_b^2$; If the bank does not supervise, it will lose S, and the total income is R_b ;

H8: The cost of doing business with government incentives is U_g^1 , the cost of doing business without government incentives is U_g^2 , ($U_g^1 > U_g^2$), if the government provides incentives, in carrying out logistics finance activities, companies that keep their promises will receive government incentives of Q. The cost of the government not providing incentives is 0 and the benefit is R_g^0 The benefit of government incentive is R_g^1 and the benefit of no government incentive is R_g^2 and ($R_g^1 > R_g^2$).

The combination of participant actions in the game includes the following.

(1) financing firms keep their contracts (Y1), logistics firms keep their contracts (Y2), banks provide oversight (Y3), and governments provide incentives (Y4).

(2) financing firms keep their contracts (Y1), logistics firms keep their contracts (Y2), banks provide oversight (Y3), and governments do not provide incentives (N4).

(3) financing firms keep their contracts (Y1), logistics firms keep their contracts (Y2), banks conduct no supervision (N3), and governments do not provide incentives (N4).

(4) financing companies keep their contracts (Y1), logistics companies do not keep their contracts (N2), banks carry out no supervision (N3), and governments do not provide incentives (N4).

(5) Financing enterprises keep their contracts (Y1), logistics enterprises do not keep their contracts (N2), banks carry out no supervision (Y3), and the government does not stimulate (N4)

(6) compliance by financing firms (Y1), compliance by logistics firms (Y2), no monitoring by banks (N3), and government incentives (Y4).

(7) financing firms keep their contracts (Y1), logistics firms do not (N2), banks provide supervision (Y3), and governments provide incentives (Y4).

(8) compliance by financing firms (Y1), non-compliance by logistics firms (N2), non-supervision by banks (N3), and government incentives (Y4).

(9) Non-compliance by financing firms (N1), compliance by logistics firms (Y2), non-monitoring by banks (N3), and

government incentives (Y4).

(10) Financing firms do not keep their contracts (N1), logistics firms keep their contracts (Y2), banks carry out supervision (Y3), and governments provide incentives (Y4).

(11) financing firms do not keep their contracts (N1), logistics firms keep their contracts (Y2), banks carry out supervision (Y3), and governments provide incentives (N4).

(12) Financing firms do not keep their contracts (N1), logistics firms keep their contracts (Y2), banks provide supervision (N3), and governments provide incentives (N4).

(13) Financing firms do not keep their contracts (N1), logistics firms keep their contracts (N2), banks provide supervision (Y3), and governments provide incentives (N4).

(14) Non-compliance by financing firms (N1), non-compliance by logistics firms (N2), monitoring by banks (Y3), and incentives by government (Y4).

(15) Non-compliance by financing firms (N1), non-compliance by logistics firms (N2), non-supervision by banks (N3), and government incentives (Y4).

(16) Non-compliance by financing firms (N1), non-compliance by logistics firms (N2), non-monitoring by banks (N3), and non-incentives by government (N4).

Table 1. Quartet Game Model Action Portfolio and Return Matrix

Quadratic game payoff matrix combinations	Earnings			
	Financing Companies	Logistics Companies	Banks	Government
(Y ₁), (Y ₂), (Y ₃), (Y ₄)	R _e ¹ - U _e ¹ + Q	R _w ¹ - U _w ¹ + Q	R _b ¹ - U _b ¹ + Q	R _g ¹ - Q
(Y ₁), (Y ₂), (Y ₃), (N ₄)	R _e ¹ - U _e ¹ + Q	R _w ¹ - U _w ¹ + Q	R _b ¹ - U _b ¹ + Q	R _g ⁰
(Y ₁), (Y ₂), (N ₃), (N ₄)	R _e ¹ - U _e ¹ + Q	R _w ¹ - U _w ¹ + Q	R _b ² - U _b ² - S	R _g ⁰
(Y ₁), (N ₂), (N ₃), (N ₄)	R _e ¹ - U _e ¹ + Q	R _w ² - U _w ² + W	R _b ² - U _b ² - S	R _g ⁰
(Y ₁), (N ₂), (Y ₃), (N ₄)	R _e ¹ - U _e ¹ + Q	R _w ² - U _w ² + W	R _b ¹ - U _b ¹ + Q	R _g ⁰
(Y ₁), (Y ₂), (N ₃), (Y ₄)	R _e ¹ - U _e ¹ + Q	R _w ¹ - U _w ¹ + Q	R _b ² - U _b ² - S	R _g ¹ - Q
(Y ₁), (N ₂), (Y ₃), (Y ₄)	R _e ¹ - U _e ¹ + Q	R _w ² - U _w ² + W	R _b ¹ - U _b ¹ + Q	R _g ¹ - Q
(Y ₁), (N ₂), (N ₃), (Y ₄)	R _e ¹ - U _e ¹ + Q	R _w ² - U _w ² + W	R _b ² - U _b ² - S	R _g ¹ - Q
(N ₁), (Y ₂), (N ₃), (Y ₄)	R _e ² - U _e ² + E	R _w ¹ - U _w ¹ + Q	R _b ² - U _b ² - S	R _g ¹ - Q
(N ₁), (Y ₂), (Y ₃), (Y ₄)	R _e ² - U _e ² + E	R _w ¹ - U _w ¹ + Q	R _b ¹ - U _b ¹ + Q	R _g ¹ - Q
(N ₁), (Y ₂), (Y ₃), (N ₄)	R _e ² - U _e ² + E	R _w ¹ - U _w ¹ + Q	R _b ¹ - U _b ¹ + Q	R _g ⁰
(N ₁), (Y ₂), (N ₃), (N ₄)	R _e ² - U _e ² + E	R _w ¹ - U _w ¹ + Q	R _b ² - U _b ² - S	R _g ⁰
(N ₁), (N ₂), (Y ₃), (N ₄)	R _e ² - U _e ² + E	R _w ² - U _w ² + W	R _b ¹ - U _b ¹ + Q	R _g ⁰
(N ₁), (N ₂), (Y ₃), (Y ₄)	R _e ² - U _e ² + E	R _w ² - U _w ² + W	R _b ¹ - U _b ¹ + Q	R _g ⁰
(N ₁), (N ₂), (N ₃), (Y ₄)	R _e ² - U _e ² + E	R _w ² - U _w ² + W	R _b ² - U _b ² - S	R _g ⁰
(N ₁), (N ₂), (N ₃), (N ₄)	R _e ² - U _e ² + E	R _w ² - U _w ² + W	R _b ² - U _b ² - S	R _g ⁰

According to the payoff matrix, we can obtain

(1) The proceeds when the financing firm keeps its contract is:

$$\begin{aligned}
&= \beta_1 \beta_2 \beta_3 \beta_4 (R_e^1 - U_e^1 + Q) + \beta_1 \beta_2 \beta_3 (1 - \beta_4) (R_e^1 - U_e^1 + Q) \\
&+ \beta_1 \beta_2 (1 - \beta_3) (1 - \beta_4) * (R_e^1 - U_e^1 + Q) + \beta_1 (1 - \beta_2) (1 - \beta_3) (1 - \beta_4) \\
&(R_e^1 - U_e^1 + Q) + \beta_1 (1 - \beta_2) \beta_3 \beta_4 * (-R_e^1 - U_e^1 + Q) \\
&+ \beta_1 (1 - \beta_2) (1 - \beta_3) \beta_4 * (R_e^1 - U_e^1 + Q) + \beta_1 \beta_2 (1 - \beta_3) \beta_4 * (R_e^1 - U_e^1 + Q) \\
&+ \beta_1 \beta_2 (1 - \beta_3) \beta_4 * (R_e^1 - U_e^1 + Q) + \beta_1 (1 - \beta_2) \beta_3 (1 - \beta_4) * (R_e^1 - U_e^1 + Q) \\
&= (\beta_1 + \beta_1 \beta_2 \beta_3 - \beta_1 \beta_2 \beta_4) (R_e^1 - U_e^1 + Q) \quad (1)
\end{aligned}$$

(2) The proceeds in case of default of the financing enterprise is:

$$(1 - \beta_1) (1 - \beta_2) (1 - \beta_3) (1 - \beta_4) (R_e^1 - U_e^1 + E) + (1 - \beta_1) (1 - \beta_2) (1 - \beta_3) \beta_4 (R_e^1 - U_e^1 + E) + (1 - \beta_1) (1 - \beta_2) * \beta_3 \beta_4$$

$$\begin{aligned}
&(R_e^1 - U_e^1 + E) + (1 - \beta_1) \beta_2 (1 - \beta_3) \beta_4 (R_e^1 - U_e^1 + E) + (1 - \beta_1) \beta_2 \beta_3 \beta_4 * (R_e^1 - U_e^1 + E) \\
&+ (1 - \beta_1) \beta_2 (1 - \beta_3) (1 - \beta_4) * (R_e^1 - U_e^1 + E) + (1 - \beta_1) \beta_2 \beta_3 (1 - \beta_4) * (R_e^1 - U_e^1 + E) \\
&+ (1 - \beta_1) \beta_2 (1 - \beta_3) \beta_4 * (R_e^1 - U_e^1 + E) + (1 - \beta_1) (1 - \beta_2) \beta_3 (1 - \beta_4) * (R_e^1 - U_e^1 + E) \\
&= (\beta_1 + \beta_1 \beta_2 \beta_3 + \beta_1 \beta_2 \beta_4) (R_e^1 - U_e^1 + E) \quad (2)
\end{aligned}$$

(3) The benefits to the bank when it conducts supervision is:

$$\begin{aligned}
&= \beta_1 \beta_2 \beta_3 \beta_4 (R_b^1 - U_b^1 + Q) + \beta_1 \beta_2 \beta_3 (1 - \beta_4) (R_b^1 - U_b^1 + Q) \\
&+ \beta_1 (1 - \beta_2) \beta_3 (1 - \beta_4) (R_b^1 - U_b^1 + Q) + \beta_1 (1 - \beta_2) \beta_3 \beta_4 (R_b^1 - U_b^1 + Q) \\
&+ (1 - \beta_1) \beta_2 \beta_3 \beta_4 (R_b^1 - U_b^1 + Q) + (1 - \beta_1) (1 - \beta_2) \beta_3 (1 - \beta_4) * (R_b^1 - U_b^1 + Q) \\
&+ (1 - \beta_1) (1 - \beta_2) \beta_3 \beta_4 (R_b^1 - U_b^1 + Q) \\
&= (\beta_3 + \beta_1 \beta_3 - \beta_2 \beta_3) (R_b^1 - U_b^1 + Q) \quad (3)
\end{aligned}$$

(3) The benefits when the bank does not supervise is:

$$\beta_4 = \frac{(1+\beta_1-\beta_2)(R_b+Q)}{\left[\frac{1+\beta_1\beta_2+(\beta_1-1)}{\beta_3}\right](R_b-S)} \quad (13)$$

$$\begin{aligned} &= \beta_1\beta_2(1-\beta_3)(1-\beta_4) * (R_b^1 - U_b^1 - S) + \beta_1(1-\beta_2) \\ &(1-\beta_3)(1-\beta_4)(R_b^1 - U_b^1 + S) + \beta_1\beta_2(1-\beta_3)\beta_4 * (R_b^1 - \\ &U_b^1 - S) + \beta_1(1-\beta_2)(1-\beta_3)\beta_4(R_b^1 - U_b^1 + S) + (1-\beta_1)\beta_2 \\ &(1-\beta_3)\beta_4(R_b^1 - U_b^1 + S) + (1-\beta_1)\beta_2\beta_3\beta_4(R_b^1 - U_b^1 + \\ &Q) + (1-\beta_1)(1-\beta_2)(1-\beta_3)\beta_4(R_b^1 - U_b^1 + S) + (1-\beta_1)(1- \\ &\beta_2)(1-\beta_3)(1-\beta_4)(R_b^1 - U_b^1 + S) \\ &= (1+\beta_1\beta_2\beta_4 + \beta_1\beta_3\beta_4 - \beta_3) * (R_b^1 - U_b^1 - S) \quad (4) \end{aligned}$$

Logistics companies comply with the agreement and do not participate in the proceeds of collusion as:

$$\begin{aligned} &= \beta_1\beta_2\beta_3\beta_4(R_w^1 - U_w^1 + Q) + \beta_1\beta_2\beta_3(1-\beta_4)(R_w^1 - \\ &U_w^1 + Q) + \beta_1\beta_2(1-\beta_3)(1-\beta_4) * (R_w^1 - U_w^1 + Q) + \\ &\beta_1\beta_2(1-\beta_3)\beta_4(R_w^1 - U_w^1 + Q) + (1-\beta_1)\beta_2(1-\beta_3)\beta_4 * \\ &(R_w^1 - U_w^1 + Q) + (1-\beta_1)\beta_2\beta_3\beta_4(R_w^1 - U_w^1 + Q) + (1- \\ &\beta_1)\beta_2\beta_3(1-\beta_4)(R_w^1 - U_w^1 + Q) + (1-\beta_1)\beta_2(1- \\ &\beta_3)(1-\beta_4)(R_w^1 - U_w^1 + Q) \\ &= (\beta_2 - \beta_2\beta_3 + \beta_1\beta_3)(R_w^1 - U_w^1 + Q) \quad (5) \end{aligned}$$

Logistics companies defaulted and the proceeds from participation in the conspiracy is:

$$\begin{aligned} &= \beta_1(1-\beta_2)(1-\beta_3)(1-\beta_4)(R_w^1 - U_w^1 + W) + \beta_1(1- \\ &\beta_2)\beta_3(1-\beta_4)(R_w^1 - U_w^1 + W) + \beta_1(1-\beta_2)\beta_3\beta_4(R_w^1 - \\ &U_w^1 + W) + \beta_1(1-\beta_2)(1-\beta_3)\beta_4(R_w^1 - U_w^1 + W) + \beta_1(1- \\ &\beta_2)\beta_3(1-\beta_4)(R_w^1 - U_w^1 + W) + (1-\beta_1)(1-\beta_2)\beta_3\beta_4 \\ &(R_w^1 - U_w^1 + W) + (1-\beta_1)(1-\beta_2)(1-\beta_3)\beta_4(R_w^1 - U_w^1 + \\ &W) + (1-\beta_1)(1-\beta_2)(1-\beta_3)(1-\beta_4)(R_w^1 - U_w^1 + W) \\ &= (1-\beta_2 + \beta_1\beta_2\beta_4 + \beta_1\beta_3\beta_4)(R_w^1 - U_w^1 + W) \quad (6) \end{aligned}$$

From equations (1)-(6), we can obtain the equilibrium returns of financing firms, logistics firms, and banks, respectively.

The equilibrium return of the financing firm is:

$$\frac{(\beta_1 + \beta_1\beta_2\beta_3 - \beta_1\beta_2\beta_4)(R_e^1 - U_e^1 + Q)}{(\beta_1 + \beta_1\beta_2\beta_3 + \beta_1\beta_2\beta_4)(R_e^1 - U_e^1 + E)} = \quad (7)$$

The equilibrium revenue of logistics enterprises is

$$(\beta_2 - \beta_2\beta_3 + \beta_1\beta_3)(R_y^1 - U_y^1 + Q) = (1 - \beta_2 + \beta_1\beta_2\beta_4 + \beta_1\beta_3\beta_4)(R_e^1 - U_e^1 + W) \quad (8)$$

Equilibrium benefits of bank supervision with or without logistics finance.

$$(\beta_3 + \beta_1\beta_3 - \beta_2\beta_3)(R_y^1 - U_y^1 + Q) = (1 + \beta_1\beta_2\beta_4 + \beta_1\beta_3\beta_4 - \beta_3)(R_e^1 - U_e^1 - S) \quad (9)$$

Make $R_e^1 - U_e^1 = R_e$, $R_b^1 - U_b^1 = R_b$, $R_w^1 - U_w^1 = R_w$ arrive at:

$$\beta_1 = \frac{(1-\beta_2)(R_w+W)/(R_w+Q) - \beta_2(1-\beta_3)}{\beta_3 - \beta_4(\beta_2 + \beta_3)(R_w+W)/(R_w+Q)} \quad (10)$$

$$\beta_2 = \frac{(1+\beta_3\beta_4)(Q-E)}{\beta_3(R_e+Q) + (R_e+E)} \quad (11)$$

$$\beta_3 = \frac{\beta_2\beta_4(E+1)-Q}{(\beta_4-\beta_2)Q - \beta_4E} \quad (12)$$

From (10)-(12), we can see that the probability of default or not of financing and logistics enterprises is related to the government incentive policy, and their probability of receiving or not keeping the contract is inversely related to the government incentive, when $W > Q$ or $E > Q$, the probability of collusion between logistics enterprises and financing enterprises is great, and default can enable financing enterprises and logistics enterprises to maximize their gains, when $W < Q$ or $E < Q$, if the government incentive policy or the cost of default makes the benefits of logistics enterprises and financing enterprises larger than their benefits of not colluding to default, then the two will keep the contract as much as possible and not collude. It can also be seen that the bank is profitable only when $R_b > S$ the bank is profitable, and the bank's gain is negatively correlated with the government incentive policy. Since the government incentive policy makes both financing and logistics enterprises comply with the contract and do not breach the contract to conspire for profit and increase their self-awareness, this will reduce the bank's supervision cost and the probability of bank supervision will be reduced, and vice versa.

From the above analysis, it can be seen that to reduce the risk of logistics finance business, the following points should be achieved.

(1) for financing enterprises and logistics enterprises, due to market risks, information asymmetry, market failure and other factors and market management system is not perfect, financing enterprises and agricultural logistics enterprises also need to reach a consensus to establish a set of logistics warehouse receipt management system recognized by both sides to control the risk of warehouse receipts, due to the current stage of China's production and management of warehouse receipts is not standardized, the production of warehouse receipts are diverse In order to prevent some agricultural products logistics enterprises will seize the legal loopholes of warehouse receipt vouchers and bill of lading vouchers production forgery, in order to obtain the trust of banks and financing guarantee enterprises and not be held legally responsible. In the financing enterprise logistics finance operation, should also strengthen the credit accumulation, and establish stable business transactions with financial institutions, so as to disperse the security risk brought by various factors.

(2) For banks, if they want to gain revenue, they need to raise the loan interest rate. In order to reduce the risk, banks need to consider from the customer's point of view so that the customer can obtain financing to maximize the expected return as a way to reduce the risk of default. The greater the operational capacity and revenue of logistics enterprises, the more banks can reduce business risks. In logistics finance risk prevention, the bank's risk mainly comes from the customer, while the customer credit risk mainly focuses on the customer's financial status, credit risk, operating ability, profitability, potential for future growth, and enterprise guarantee status. Banks mainly review the creditworthiness of customers from two aspects: firstly, the creditworthiness and solvency of agricultural logistics enterprises should not be overestimated; secondly, logistics enterprises have good creditworthiness in the early stage, but cannot repay the loans and interest on time due to poor operation in the later stage,

which makes banks suffer losses. Therefore, in the process of carrying out logistics finance business, banks should establish a comprehensive enterprise performance evaluation system for logistics enterprises, and on the basis of lessons learned in previous logistics finance business projects, they should also evaluate the repayment ability of financing enterprises in all aspects.

(3) The government should increase the policy support for financing enterprises and logistics enterprises in terms of tax concessions, bank loan interest subsidies, etc., in order to help financing enterprises to expand their business scale after obtaining financing, thus increasing employment and tax revenue. On the other hand, the government should also improve the relevant logistics finance laws and regulations and formulate the relevant logistics finance system and penalty clauses to prevent the occurrence of logistics finance risks.

4. Conclusion

Logistics finance can promote the development of logistics enterprises, enhance the profits of logistics enterprises and the whole logistics industry chain, while the development of logistics finance can enhance the coordination between the flow of funds of logistics enterprises and other businesses such as procurement, distribution, re-search and development, help small and medium-sized financing enterprises to solve financing problems, reduce the difficulty of commercial banks to supervise financial risks, and continuously promote the theoretical and practical business development of logistics finance industry. It can directly improve the management level and ability of logistics enterprises. Logistics enterprises, financing enterprises and banks must make accurate judgments and assessments of the possible risks associated with the existence of logistics finance business, and finally achieve Pareto optimality. This paper establishes a four-party participant behavior game model using game theory knowledge, and concludes through model calculation that whether logistics enterprises and financing enterprises keep their contracts is positively correlated with government incentive policy, and whether banks supervise is negatively correlated with government incentive policy. On this basis, suggestions for risk reduction in agricultural logistics finance are put forward, which are hoped to be helpful to the relevant interest subjects involved in the game.

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