Research on Credit Risk and Risk Management Countermeasures in the Operation of Blockchain + Supply Chain Finance

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Abstract. Credit risk is the main contradiction that plagues the sustainable development of blockchain + supply chain finance. The default of individual credit subjects will spread to the entire supply chain, and the credit chain will collapse, and the entire credit order will be disorder. Aiming at the credit risk problems faced by blockchain + supply chain finance, this paper gives credit risk management measures for credit risk management in the pre-loan access stage, loan approval stage, and post-loan management stage. Combining the application value of blockchain + supply chain finance, the relevant policy recommendations proposed in this paper include setting up a trial operation period of block chain + supply chain finance, gradually improving the trading rules, and building a risk early warning mechanism.

Keywords - blockchain, supply chain finance, credit risk, risk management

1. INTRODUCTION

The credit risk in the operation of blockchain + supply chain finance means that the financing enterprises on the chain cannot fulfill the obligation of paying principal and interest repayment on schedule. The credit risk refers to the possibility of risk loss brought to the upstream enterprises and capital suppliers in the supply chain [1].

2. CREDIT RISK PROBLEMS FACED BY BLOCKCHAIN + SUPPLY CHAIN FINANCE

2.1 Source of Credit Risk for Blockchain + Supply Chain Finance

The credit risk in the operation of blockchain + supply chain finance comes from economic cyclicality and individual business differences. Among them, economic cyclicality is an objective factor of credit risk. Individual business differences are the subjective factors of credit risk. When the economic cycle is at the bottom, the profitability of the borrower's enterprise is

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weakened, resulting in its inability to fulfill the obligation to repay the principal and interest on schedule. Conversely, when the economic cycle is in the upward phase, the profitability of the borrower's enterprise rises substantially. As a result, the risk of credit default in the financing process is reduced. The business differences of the borrower's enterprise will affect its financing credit risk. For example, the enterprise's managerial decision-making mistakes lead to a unsalable inventory of the enterprise's goods, and the capital chain breaks.

2.2 Credit Risk Management Strategies for Blockchain + Supply Chain Finance

Credit risk is the main contradiction that plagues the sustainable development of blockchain + supply chain finance. The default of individual credit subjects will spread to the entire supply chain, and the credit chain will collapse, and the entire credit order will be in a state of disorder. Risk avoidance, risk suppression, risk transfer, and risk retention are still common strategies for credit risk management. Traders should flexibly choose risk management strategies based on the probability of risk occurrence and the degree of risk loss.

- Risk avoidance

Risk avoidance is a strategy of shutting the door on credit relationship entities with large risk losses and a high probability of risk occurrence. That is, by setting credit access thresholds to eliminate bad credit related parties, the risk of credit default in the financing process approaches zero. Credit rating is the basis for setting the entry threshold. The internationally accepted rating standards are three-class nine-level (AAA, AA, A; BBB, BB, B; CCC, CC, C). Among them, BBB-AAA is the entry level of the credit threshold, and C-BB is the subordinate credit subject.

- Risk suppression

Risk suppression is a risk management strategy for credit relationship entities with low risk loss and high risk occurrence probability. The sum of a series of measures is taken to narrow the scope of risk loss and reduce the degree of risk loss when or after the risk loss actually occurs. By itself, it cannot reduce the probability of occurrence of credit default risks, such as risk management strategies that allow for repayment conditions.

- Risk transfer

Risk transfer is a risk management strategy for credit relationship entities with large risk losses and low risk occurrence probability. Part or all of the risk loss is passed on through contract or non-contract. The credit risk in the operation of blockchain + supply chain finance can be transferred in the form of performance bond. One of the debtors needs to pay a deposit in accordance with a certain proportion of the financing amount, and the deposit is used as a guarantee for fulfilling the repayment obligation.

- Risk retention

Risk retention is a risk management strategy for credit relationship entities with small risk losses and low risk occurrence probability. That is, the creditor actively assumes the credit default risk of the debtor and uses the creditor's economic resources to offset the credit risk loss. For example, in order to avoid the credit default risk of small, medium and micro enterprises, local commercial banks adopt a strategy of decentralizing small loans.

3. CREDIT RISK MANAGEMENT IN THE OPERATION OF BLOCKCHAIN + SUPPLY CHAIN FINANCE

Based on the business closure characteristics of blockchain + supply chain finance, lending banks should establish a closed loop of risk management for pre-loan access, mid-loan approval, and post-loan management.

3.1 Credit Risk Management in the Pre-loan Access Stage

Risk management and control at the pre-loan access stage should adopt risk aversion strategies, and limit the access of sub-credit entities based on the corporate credit rating. Enterprise credit rating is a complete framework system, including credit rating elements, credit rating indicators, credit rating standards, credit rating methods, etc. Among them, credit rating indicators and credit rating methods are the core content of corporate credit rating. Enterprise credit rating indicators (see table I) mainly involve enterprise quality, financial structure, profitability, debt solvency, development prospects. Among them, corporate quality includes corporate operating capabilities and managerial quality.

TABLE I. ENTERPRISE CREDIT RATING INDEX SYSTEM

Rating items	Single full marks	Single rating qualified score line	Single rating score line
Enterprise quality	30	21	27
1.1 Inventory turnover ratio	10	7	9
1.2 Turnover ratio of receivable	10	7	9
1.3 Manager's personal credit records	10	7	9
2. Financial structure	10	7	9
2.1 Financial leverage ratio	5	3.5	4.5
2.2 The ratio of current liabilities to total liabilities	5	3.5	4.5
3. Profitability	20	14	18
3.1 Gross profit margin	10	7	9
3.2 Sales net interest rate	10	7	9
4. Debt paying ability	20	14	18
4.1Asset-liability ratio	10	7	9
4.2 Current ratio	10	7	9
5. Prospects for development	20	14	18
5.1 Market share of the product or services	10	7	9
5.2 Supply chain business flow transaction rate	10	7	9

3.2 Credit Risk Management in the Approval in Loan Stage

The risk management and control during the loan approval stage include two levels. They are loan line approval, contract interest rate formulation. Loan line approval should pay attention to the borrower's credit default probability. The setting of contract interest rates should pay attention to risk premium factors. During the loan approval stage, big data analysis technology can be used to reduce the error rate of credit granting. Supply chain batch approval can improve the efficiency of pre-loan approval, and blockchain technology can assist in the approval of loan quotas.

- Approval of loan quota

Approval of loan lines should be combined with the credit default probabilities of different borrowers to formulate reasonable loan credit lines. The probability of credit default refers to the possibility that the borrower will not be able to repay the principal and interest on schedule in a certain period in the future. Under normal circumstances, the credit default probability needs to track the past credit records of the borrower's enterprise, and use the past records to speculate the credit default probability for a period of time in the future. Assumption: A company's past credit default probability is 1%, and the expected default probability is equal to 1% plus or minus the probability of random adjustment. The probability of random adjustment is similar to Brownian motion Wt. When Wt exceeds the critical value ρ, a credit default event will occur. In order to control the risk of credit default, commercial banks often make credit investment portfolios. According to the expected default probability of the borrower's enterprise, different loan quotas are allocated. Q is the total loan amount, ω is the credit rationing rate, and Q1 to Qn are the credit rationing amount (see equation 1). The credit rationing rate ω is equal to the expected performance probability e of the borrower's enterprise divided by the total performance probability E. The total performance probability is equal to the sum of the expected performance probabilities of different borrower companies (see equation 2). Among them, the probability of performance is equal to 1 minus the probability of default.

$$Q = \sum_{i=1}^{n} \omega_1 Q_1 + \omega_2 Q_2 + \cdots \omega_n Q_n \tag{1}$$

$$\omega_1 = (e_1)/(E_1 + E_2 + \cdots E_n) \tag{2}$$

- Contract interest rate formulation

Loan banks should specify differentiated loan contract interest rates in conjunction with corporate credit ratings. The loan contract interest rate is equal to the benchmark loan interest rate plus the risk premium. The influencing factors of risk premium (see table II) include corporate credit rating (weight of 30%), mortgage rate (weight of 20%), guarantee method (weight of 20%), cooperation duration (weight of 20%) and credit records (weight 10%). The risk premium is reflected as the interest rate floating level and the interest rate floating level λ is equal to 1 minus the weighted ratio of the credit risk premium. The weight distribution rate is equal to the weight distribution divided by 100. For example, in the calculation of the weight distribution of the credit risk premium, the weight distribution of a certain company is 95, the weight distribution rate is 95%, and the interest rate floating level λ is equal to 5% (see

equation 3). The loan contract interest rate i is equal to the benchmark loan interest rate of 7% multiplied by 1 plus 5% (see equation 4).

$$\lambda = 1 - 95\% = 5\% \tag{3}$$

$$i = 7\% \times (1 + 5\%) = 7.35\% \tag{4}$$

TABLE II. WEIGHT TING OF CREDIT RISK PREMIUM

Item	Weight match	Assignment
1. Enterprise credit rating	30%	Full 30
1.1 AAA		30
1.2 AA		20
1.3 A		10
1.4 BBB		5
2.Mortgage rate m	20%	Full 20
2.1 m＞120%		20
2.2 100%≤m≤120%		10
3. Guaranty style	20%	Full 20
3.1 Guarantee		20
3.2 Impawn		15
3.3 Mortgage		10
4.Length of cooperation t	20%	Full 20
4.1 t≥5 years		20
4.2 3years ≤t＜5 years		10
4.3 1 year ≤t＜3 years		5
5. Credit investigation records	10%	Full 10
5.1 Having no illicit records		10
5.2 Having illicit records		0

- Credit risk management at the post-loan management stage

The risk management and control at the post-loan management stage is mainly aimed at reducing the loss of non-performing loans. Its risk management strategy includes risk suppression and risk transfer. Risk suppression is a risk management strategy for credit relationship entities with low risk loss and high risk occurrence probability. Risk transfer is a risk management strategy for credit relationship entities with large risk losses and low risk occurrence probability. It means that part or all of the risk loss is passed on through contract or non-contract.

- Risk suppression strategy in the post-loan management stage

Overdue loans belong to non-performing loans. In order to reduce the loss of non-performing loans as much as possible, lending banks often adopt risk suppression strategies. It means to

encourage borrowers to repay the debt principal and interest as soon as possible through graceful repayment conditions. For example, during the 2020 epidemic prevention and control period, individual companies have been unable to resume normal production and operation activities due to the fluctuation of the epidemic. Based on this, the lending bank has implemented grace repayment conditions for enterprises. The primary problem faced by enterprises in resuming work and production is the shortage of funds. In order to assist enterprises in resuming normal production and operation activities, the grace repayment conditions implemented by lending banks include exemption of interest owed in the previous period, the extension of the repayment period, and additional loan principal. With the support of bank credit, in March 2021, the company has ushered in a new market opportunity, and its operating conditions have been rapidly improved. The principal and interest of the loan owed in the previous period will be returned to the lending bank in one lump sum.

- Risk transfer strategy in the post-loan management stage

The risk transfer strategy at the post-loan management stage only targets non-subjective default behaviors. It means the risk of credit default is transferred through the form of performance bond. Blockchain + supply chain finance implements a transaction membership system, and traders need to pay dues in accordance with regulations. In addition, the debtor must pay an initial deposit in accordance with a certain percentage of the financing amount. During the loan financing period, according to changes in the debtor's solvency, the third-party regulatory agency may require the debtor to add performance bonds. The performance bond is managed by a third-party regulatory agency, and the fund manager is entrusted to conduct investment operations. The investment income is used to make up for the credit risk losses of the commercial bank. For example, in the blockchain + supply chain financial system, the total credit investment is 50 million yuan. The credit default risk loss rate is 0.3%, and the loss is 150,000 yuan. The total performance bond paid by the debtor is 3 million yuan, and the fund manager invests and manages the performance bond with a return rate of 5% and an income of 150,000 yuan. As a result, the profit and loss compensation in the post-loan management stage is realized.

4. RESEARCH CONCLUSIONS AND RELEVANT POLICY RECOMMENDATIONS

4.1 Research Conclusion

- Application value

[2][3][4] Block chain + supply chain finance refers to the implantation of block chain technology into the supply chain financial system, and the use of block chain shared databases to carry commercial credit at the end of the supply chain. Therefore, a green channel is opened for the credit financing of small, medium and micro enterprises at the end of the supply chain. [5] The operational advantage of blockchain + supply chain finance is reflected in the decentralized distributed node data. All nodes in the system can send and receive information equally, and the consensus algorithm maintains the authenticity and reliability of distributed ledger records. Blockchain technology can greatly reduce the cost of information collection and improve the efficiency of supply chain financing. Distributed ledgers, asymmetric encryption,

consensus mechanisms, and smart contracts endow the application value of blockchain + supply chain finance.

- Credit risk in the operation of the blockchain + supply chain finance

Credit risk is the main contradiction that plagues the sustainable development of blockchain + supply chain finance. The default behavior of individual credit subjects will spread to the entire supply chain, and the credit chain will collapse, and the entire credit order will be in a state of disorder. The formation factor of credit risk may be the malicious subjective behavior of the credit subject. It may be restricted by external objective conditions that cause the credit subject to lose the ability to perform the contract. The credit risk in the operation of blockchain + supply chain finance refers to the possibility of risk loss caused by the financing enterprises on the chain to the upstream enterprises and capital suppliers of the supply chain because they cannot fulfill the obligation of repaying the principal and interest on time.

4.2 Relevant policy recommendations

- Set up the trial operation period of blockchain + supply chain finance

Blockchain + supply chain financial services for small, medium and micro enterprises in Dalian Free Trade Zone must not venture into financing. Reference should be made to the blockchain + supply chain financial service platform promoted by the domestic public companies and gradually implementing the basic plans to connect supply chain finance. In fact, the launch and implementation of blockchain + supply chain finance will still face problems such as difficult technical supervision, difficult service management updates, and high legal compliance risks. Based on this, blockchain + supply chain financial services need to go through a trial operation stage for the real economy development of Dalian Free Trade Zone.

- Gradually improve the trading rules

Blockchain + supply chain financial services for the real economy in the Dalian Free Trade Zone require a relatively complete set of transaction rules to control the risk of credit default in the process of financing and lending. Blockchain + supply chain finance should implement a transaction membership system, and traders need to pay dues in accordance with regulations. In addition, the debtor must pay an initial deposit in accordance with a certain percentage of the financing amount. During the loan financing period, according to changes in the debtor's solvency, the third-party regulatory agency may require the debtor to add performance bonds. The performance bond is managed by a third-party regulatory agency, and the fund manager is entrusted to carry out low-risk investment operations. The investment income can be used to make up for the credit risk losses of commercial banks.

- Establish a risk early warning mechanism

Based on the business closure characteristics of blockchain + supply chain finance, lending banks should establish a risk management closed loop of pre-loan access, loan approval, and post-loan management. Risk management and control at the pre-lending access stage should adopt risk aversion strategies, and limit the access of sub-credit entities based on the corporate credit rating. Risk management and control in the loan approval stage include loan quota approval and contract interest rate setting. Loan approval should pay attention to the borrower's credit default probability. The setting of contract interest rates should pay attention to risk

premium factors. The risk management and control at the post-loan management stage is mainly aimed at reducing the loss of non-performing loans. Its risk management strategy includes risk suppression and risk transfer.

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