

Research on Blockchain in Supply Chain Finance Risk Management

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Abstract. With the development of supply chain finance, the business process of supply chain finance is more complex, and the participants are more diversified, bringing new risks to supply chain finance. Based on studying the risk sources and types of supply chain finance, combined with the core technology of blockchain and taking the blockchain + supply chain finance accounts receivable financing mode as an example, this paper proposes that blockchain can solve the problem of information asymmetry by reshaping the information flow of supply chain finance, breaking down information barriers, improving the credibility and transparency of information and expanding the scope of credit through smart contracts and distributed ledger technologies. In addition, financial institutions can reduce moral hazards and review costs caused by human operations through the characteristic advantages of blockchain consensus mechanism and traceability and ensure the authenticity and security of transaction information through the asymmetric key method and sharing mechanism of blockchain.

Keywords: Blockchain; Supply Chain Finance; Financial Risk Management.

1. Introduction

By the end of 2022, there were more than 52 million small and medium-sized enterprises (SMEs) in China, with an average of 23,800 new enterprises established every day in 2022. SMEs are the largest and most dynamic enterprise group in China [1] and an important force for promoting China's economic and social development. However, due to the small scale of SMEs, high operational risks and information asymmetry, financial institutions are unwilling to provide financial support for them, which causes the financing difficulty of SMEs. To effectively solve the problems such as information asymmetry and credit investigation in SME financing, the supply chain finance business emerges at the historic moment. Williams-Timme put forward the definition of supply chain finance for the first time. Supply chain finance is a business generated by cooperation between participants in the supply chain and external financial institutions. Supply chain finance is a process of collaboration, during which commercial flow, logistics, capital flow, information flow and corresponding assets need to be considered and incorporated into the operation and management of the supply chain [2]. Supply chain finance consists of multiple organizations. Supply chain finance is a financing mode in which banks and other financial institutions collect, analyze, and evaluate supply chain information to meet the capital needs of enterprises that meet the standards on the chain in time. In other words, supply chain finance is a variety of financing services designed and provided by banks for all participants in the supply chain based on the needs of transactions such as procurement, inventory, and sales, and makes full use of the self-liquidity characteristics of transactions to mitigate risks and save capital occupation. On the premise of mastering the whole process of supply chain business, supply chain finance is to carry out whole-supply chain financing based on the credit resources of core enterprises. It regards core enterprises and upstream and downstream enterprises as a whole and enhances credit by supervising the whole process of business flow, logistics, capital flow and information flow between core enterprises and upstream and downstream customers. This kind of closed self-liquidating financing mode through the supply and marketing channels, credit guarantees, and other means of core enterprises provides SMEs with the funds needed for development and revitalizes their non-cash flow. However, due to the involvement of supply chain finance participants in various industries such

as industry, finance and logistics, supply chain finance is characterized by many business processes, complex risk control methods and strong risk linkage among subjects. With the development of science and technology and the innovation of business models, traditional supply chain finance models have exposed many problems such as asymmetric information, opaque transactions and easy data stealing and tampering. Therefore, blockchain technology can better promote the development of supply chain finance business. This paper first expounds the definition and characteristics of blockchain technology, then explains the problems existing in traditional supply chain finance, and finally puts forward relevant suggestions on optimizing supply chain finance risks from the perspective of risk types for supply chain finance.

2. Relevant Theoretical Basis

Different from traditional enterprise financing, the subjects of supply chain finance are diversified, and this mode has more small and medium-sized enterprises. On the one hand, China does not have a perfect credit evaluation and assessment system for SMEs. On the other hand, the operation of SMEs is comprehensively affected by supply chain, cooperation and competition among enterprises and market environment, which makes it difficult to estimate the risk of supply chain finance. In addition, manual investigation will be used in the process of supply chain finance operation. It is difficult to identify various fraudulent behaviors such as forged financial data, trade documents and real estate pledge materials through manual investigation. For example, Shanghai Steel Trade Fraud Case is caused by repeated pledge problems of steel trading enterprises. Shensai Materials will provide the same pledge to Huaxia Bank and ICBC for loan financing respectively. Due to human factors such as the lack of communication between banks and loopholes in warehouse management, repeated pledge or empty bill pledge by cargo owners and warehousing enterprises will trigger supply chain crisis. Traditional supply chain finance operations are tedious, and a large number of information verification and process tracking need manual operation. Therefore, the labor cost will increase due to excessive supply chain finance, or risks will occur due to manual operation errors or intentional manipulation.

With the emergence of new blockchain technologies, every asset and transaction in any link of the supply chain can be traced back to its source. Blockchain is a distributed ledger formed by appending consensus-confirmed blocks in sequence using cryptographic technology [3]. With the development of blockchain technology, different scholars have defined it from the perspectives of law and data life cycle. If blockchain is regarded as a behavior, the minimum number of subjects participating in this behavior should be three and supported by data. Algorithms are processing tools. Distributed bookkeeping is used throughout the behavior, data cannot be tampered with at will, and no third-party intermediary is required to achieve specific transaction purposes [4]. If blockchain is defined from the full life cycle of dynamic data, it is a brand-new decentralized infrastructure and distributed computing paradigm. Specifically, data verification and storage are realized by encrypted chain block structure, distributed nodes and consensus mechanism ensure the generation and update of data, and data programming and operation rely on smart contracts embedded with automatic execution script codes [5]. To sum up, blockchain technology is a very reliable shared database and distributed ledger. It uses distributed data storage, hash function, data encryption, smart contract, peer to peer, consensus mechanism and other technologies to realize the characteristics of non-forgery and transparency of on-chain data. In the structure of blockchain, the lowest layer is the data layer, including block data and chain structure of blockchain, as well as random numbers, timestamps, public and private key data on blocks. The data layer is a tamper-resistant distributed database [6]. The data layer saves and manages the transaction records [7] in the database through Merkle tree, hash function and corresponding encryption technology, such as transaction time and transaction information data, and ensures the security of all data when publicized throughout the network. In addition, the core layer of blockchain is consensus layer, which can adjust and develop test environments and algorithms. For example, smart contract testing and optimization, digital signature development verification, block data development and consensus mechanism development test are carried out to enable highly

decentralized nodes to efficiently reach a consensus on the validity of block data in the decentralized blockchain network. The consistency mechanism is adopted between nodes to ensure the consistency of the data layer. Therefore, blockchain technology is characterized by decentralization, tamper-proofness, traceability, security, and anonymity. Each block of the blockchain technology contains a unique hash value calculated from the content of the previous block on the chain. The important characteristics of the hash value are input sensitivity and reverse difficulty. When inputting information, even if a character is tampered with, the regenerated hash value is different from the original hash value, and the mismatch with the next block record is easy to be detected by other nodes. Therefore, the hash value can be used to verify whether the contents of two files are identical and whether they are damaged or tampered with during file checking or data transmission. Therefore, blockchain technology ensures the non-tamperability of data and information through chain structure features composed of hash values. All data on the blockchain are encrypted and stored in electronic form. In addition to hash values, blockchain technology is also attached with time stamps, which are attached every time a block is formed to indicate the recording time. This decentralized, distributed multi-node structure, multi-node joint bookkeeping mode, data encryption, economic incentives and other means can establish trust relationship in supply chain finance. Blockchain also includes digital signature, consensus mechanism, smart contract, and other technologies. Digital signature is to process the signature content through an asymmetric encryption algorithm. Each node of the blockchain needs a pair of private and public keys. The identity of the message sender is proved by using a private key when signing data, that is, only the user has the private key. A public key, which is accessible to all, needs to be used for signature verification. Therefore, all nodes can verify the validity of their identities. In a blockchain network, each node has a public-private chain pair. When a node sends a transaction, it first uses its private key to sign the transaction content and attaches the signature to the transaction. After receiving the message, other nodes first verify the digital signature attached to the transaction. The subsequent process will be triggered only after the message integrity verification and the identity validity verification of the message sender are completed. This ensures data integrity and authenticity of the sender's identity. The consensus system of blockchain includes consensus algorithms for proof-of-work, credential, Byzantine Fault Tolerance (BFT) and Trusted Execution Environment (TEE), which are less complex. It has high security [8], which can limit the nodes participating in consensus in the blockchain system and eliminate irregular or malicious operations of malicious nodes to a large extent. A smart contract is an electronic protocol that forms a transaction into a set of commitments defined in digital form and automatically enforces the execution of the commitments according to preset trigger conditions [9]. The smart contract design must contain regular contractual terms such as payment conditions, confidentiality of asset liens and information, and triggering enforcement. This design eliminates the need for intermediaries such as arbitration institutions, simplifies transaction steps, reduces malicious and accidental exceptions, reduces disputes over contract performance between both parties to a transaction, and lowers transaction costs. These core technical advantages enable supply chain finance to be characterized by authentic data, open sharing, information security, tamper-proof traceability, and privacy protection [10].

3. Research Status of Blockchain and Risk Management for Supply Chain Finance

Some scholars take the factors triggering supply chain finance risks as a breakthrough point to study the measures of blockchain technology to reduce risks. For example, Ma Xiaofeng pointed out that asymmetric information of enterprise pledges is easy to cause repeated pledge or empty single pledge, which is not conducive to the interests of financing parties. Building a supply chain finance platform based on blockchain technology can enhance trust mechanism and effectively isolate crises [11]. Wu Jun believes that the application of blockchain technology is conducive to realizing the unification and cross-validation of supply chain finance data flows (such as capital and logistics, information flow and business flow), solving the dilemma of "information silo", enabling full and timely flow of information, increasing the transparency of information, and reducing the risk of fraud [12].

Some scholars have analyzed the application of blockchain technology in supply chain finance based on core technologies and cases. Li Jiajia and Wang Zhengwei selected supply chain finance cases such as Haier Financial Holdings and Ant Financial Shuangliantong to analyze the risks and pointed out that the characteristics of blockchain technology can help enterprises reduce information asymmetry, increase trade authenticity, and reduce credit risk [13]. Zhu Xingxiong et al. pointed out that the alliance chain in blockchain is jointly built by the main participants of supply chain finance, and the information on the chain can be cross validated through blockchain technology, to strengthen the authenticity review of transactions and avoid fraud risks [14]. Li Bo pointed out that the decentralization of blockchain technology eliminates the need for third-party institutions to transfer value, solving the trust problem in supply chain finance. The architecture of blockchain technology can solve the existing data distortion problem and improve information sharing and transparency [15]. Zhang Lu analyzed the incentive mechanism of blockchain technology and pointed out that mutual trust problems and fair benefit distribution problems that have been difficult to solve in supply chain finance can be properly solved with blockchain technology, which can reduce loan risks and regulatory costs [16].

4. Optimization of Risk Control for Supply Chain Finance based on Blockchain Technology

4.1. Risk Types of Supply Chain Finance

Supply chain finance risk is characterized by complexity, dynamics, contagion, and diversification. Complexity refers to the combined impact of external and internal risks on supply chain finance. External risk refers to the impact of macro environment, national economy, laws, and other policies on supply chain finance, but such risks are generally uncontrollable factors. Internal risk refers to credit risk, authenticity risk and operational risk. Credit risk refers to the risk that the debtor cannot repay on time and bring losses to the creditor. Core enterprises have strong strength in supply chain finance, and the credit qualification of core enterprises is the key. If a core enterprise has credit problems, commercial banks will reduce its credit authorization. When any violation of regulations by core enterprises occurs to privately grant credit guarantees to small and medium-sized enterprises or generate risks of their own credit, it will affect upstream and downstream enterprises and banks in the supply chain and aggravate the risk of the whole supply chain finance. In addition, upstream and downstream enterprises in the supply chain may also have credit risks due to their own operation conditions. To reduce risks, some financial institutions are only willing to grant credit ratings and provide financial support for core enterprises and suppliers and distributors at the upper and lower levels of core enterprises and rely on the credit endorsement of this enterprise for financing, rather than providing credit and funds to suppliers and distributors at more levels upstream and downstream. In other words, the credit of core enterprises can only be transmitted to upstream and downstream suppliers and distributors, rather than across levels in the supply chain. If credit risk cannot be effectively controlled, the financing problem of small and medium-sized enterprises cannot be effectively solved.

Authenticity risk refers to the difficulty in verifying the authenticity of data, bills, trade transactions and other information in the supply chain. On the one hand, there is a problem of authenticity in the input of information data on the supply chain. In addition, the common financing methods of supply chain finance are prepayment financing, inventory financing and accounts receivable financing. In receivables financing, it is difficult for banks to identify whether trade occurs. In the inventory financing model, it is difficult for banks to identify whether the information of inventories is true. In the prepayment financing mode, enterprises at different nodes have not yet established a unified standard in terms of information system and cannot realize effective interaction. That is to say, the transparency of data under the three financing modes is poor, which cannot completely reflect their real information. Even if banks invest a large amount of funds and manpower, they cannot track, supervise, and trace it timely and effectively. This is easy to cause fraud in data and transactions due

to information barriers, which slows down the circulation efficiency of supply chain information and increases disputes and mistrust between different enterprises in the supply chain.

As mentioned above, there are many participants in supply chain finance and the contents to be verified are cumbersome. Therefore, many staff are required to investigate all aspects of supply chain finance. In the credit investigation link, bank staff reviews relevant information such as the credit of counterparties and core enterprises, and the authenticity and completeness of accounts receivable and prepayment according to their own professional ability; in the loan issuance link, operators need to issue loans in a timely and accurate manner. In the loan collection process, staff members need to collect and verify funds in a timely manner. These risks can occur due to deliberate or unintentional errors of workers. In addition, manual operation will also cause moral risks of internal fraud or personnel fraud, such as colluding with supply chain enterprises to forge warehousing vouchers and withdrawing pledges without authorization.

4.2. How Blockchain Avoids Different Risks in Supply Chain Finance

Based on the core technology of blockchain mentioned above, it can avoid the credit risk of supply chain finance, data authenticity risk and moral hazard caused by operation, to avoid fraudulent risks.

First, blockchain breaks down information barriers and solves the problem of information asymmetry by reshaping the information flow of supply chain finance. All participants in supply chain finance write transaction information data into the block through blockchain technology, which uses P2P network to organize each node to participate in accounting and verification [17]. Any node can read and write data on the block, and the transaction information in the blockchain can be viewed by any authorized node. This enables all participants in supply chain finance to share supply chain information. Significantly reduce the cost of obtaining information.

Second, the smart contract and distributed ledger technology of blockchain improve the credibility of information. Smart contract technology ensures the enforcement of transactions between enterprises. Taking the blockchain + supply chain finance accounts receivable financing mode as an example, after a commercial bank completes debt information verification and Token information acquisition, it will issue loans. The blockchain + supply chain finance platform will automatically implement the setup of established smart contracts to allocate funds from each lender to its own bank account. When the set conditions are met, the supply chain platform can automatically allocate loans and deliver for settlement, thus realizing the automatic compulsory transfer of assets such as goods and funds. In this financing mode, enterprises in the supply chain can clearly understand the use of financing funds, which can further ensure the authenticity of transactions, improve performance efficiency, reduce credit risk, and effectively protect the legitimate rights and interests of all participants on the platform. In addition, blockchain decentralization and distributed ledgers improve the credibility of information. The consortium chain of blockchain technology is a decentralized ledger. All participants can see the information in the ledger, and any node on the blockchain can review the authenticity of the transaction. Only after all nodes are ensured to be true can consensus be reached, and the transaction information take effect. At the same time, enterprises at any node can issue relevant certificates, reducing the occurrence of enterprise repudiation behavior. Blockchain can carry out audit management and account settlement by tracing digital signatures and timestamps, realizing convenient and reliable interaction among various subjects in the supply chain. Blockchain supply chain finance can not only reduce credit risk, but also expand credit authorization under the account receivable financing mode. Traditional paper-based commercial paper cannot split the face value, so it will restrict the circulation of credit assets in the supply chain. Blockchain technology can convert commercial papers such as accounts receivable into digital vouchers on the blockchain, and arbitrarily split and transfer them according to actual financing needs. The credit qualifications of core enterprises are transferred between suppliers. After receiving the credit vouchers of core enterprises, first-tier suppliers can generate digital assets that can be split and transfer them to multi-level suppliers on the chain. It breaks the limitation that credit can only be transmitted to core enterprises and enterprises with close transactions under the traditional supply chain finance mode.

Through the characteristic advantages of blockchain consensus mechanism and traceability, financial institutions no longer need to review historical transactions, document history and participant identities in financing approval. Each credit asset in supply chain finance is endorsed through the whole network node, so there is no need for third-party supervision function. The institution only reviews the trade background and authenticity of core enterprises without a large amount of manual confirmation work, which reduces labor costs and moral risks caused by human operations.

Finally, the asymmetric key method of blockchain encrypts and protects transaction information. At the same time, many data operations are formed by consensus mechanism to prevent tampering with information, thus ensuring the credibility of the whole transaction information security. When the supply chain finance transaction information changes, the uploaded data will be stamped with a timestamp to ensure that the time of writing into the block is recorded accurately in chronological order, ensuring that the transaction information can be effectively traced, preventing false transaction information, and improving financing efficiency.

5. Conclusion

This paper elaborates the research and application status of blockchain + supply chain finance by reviewing literature. Taking the risks faced by traditional supply chain finance as a breakthrough point, it is proposed that blockchain technology realizes information symmetry of upstream and downstream enterprises in the supply chain through consensus mechanisms and algorithms, smart contracts, digital signatures, and other core technologies. Blockchain technology can also complete the review and execution of all business processes on the chain, to effectively record relevant information and data, ensure the authenticity and non-tampering of information and data, and make all links within the scope of supervision. Moreover, it reduces the risk of supply chain finance and expands the credit scope of financial institutions. In the future, blockchain technology can realize distributed collaboration among enterprises while protecting enterprise data and privacy security. It is necessary to promote the establishment of blockchain technical standards by promoting the development of industry and technology alliances, solving problems such as inconsistent development languages and smart contract standards, strengthening the review of smart contracts, and promoting the rapid development of blockchain + supply chain finance.

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