The Application Path and Mechanism of Blockchain Technology in Supply Chain Finance

Jun Xu

School of Finance, Guangdong University of Finance & Economics (Guangzhou Campus), Guangzhou, China
wlljun3238@qq.com

Abstract. The information asymmetry in financing has long been a challenge for small and medium-sized enterprises (SMEs), making it difficult for banks to accurately assess their credit risks. Moreover, in the traditional supply chain finance model, core bottlenecks such as data silos and the ineffective transmission of credit persist, greatly constraining financing efficiency and transparency. This study focuses on the application of blockchain technology in supply chain finance, exploring how blockchain can break through data silos, enable multi-tier credit circulation, and thereby enhance the financing efficiency of SMEs while reducing financing costs. Specifically, through normative analysis and case comparison, it examines how blockchain facilitates multi-tier credit circulation via digital debt instruments, builds trusted data pools to lower financing costs, and ensures data privacy in collaborative sharing. The findings indicate that blockchain technology can effectively rebuild the trust mechanism in supply chain finance, but its widespread adoption still faces key challenges such as technical interoperability, insufficient momentum for ecosystem development, and the absence of a legal framework. In the future, blockchain will integrate deeply with the Internet of Things (IoT) and artificial intelligence (AI), driving supply chain finance toward an intelligent, automated digital financial ecosystem.

Keywords: Supply Chain Finance, Financing for Small and Medium-sized Enterprises, Multi-tier Credit Transmission, Blockchain, Digital Debt Instrument

1. Introduction

In China, small and medium-sized enterprises (SMEs) have long encountered financing difficulties, mainly due to information asymmetry between banks and businesses, along with the challenge of extending the credit of core enterprises throughout the entire supply chain. Although supply chain finance has partially alleviated the pressure by relying on real transaction backgrounds, traditional models still encounter bottlenecks like difficulties in verifying the authenticity of trade contexts due to information silos, the inability to achieve multi-tier credit circulation, cumbersome operations consuming substantial human and material resources, as well as data privacy security concerns. By leveraging its distributed ledger, immutability, and smart contract features, blockchain technology provides a new paradigm for reconstructing the trust system in supply chain finance. This study aims to conduct an in-depth analysis of the application mechanisms and practical pathways of blockchain

technology in supply chain finance. By integrating classic theories such as information asymmetry, transaction costs, and credit rationing, it evaluates the strengths and limitations of traditional supply chain finance in addressing these challenges. Furthermore, it focuses on exploring the core functionalities of blockchain, such as distributed ledgers, consensus mechanisms, and smart contracts, and analyzes how they can effectively address the key pain points in supply chain finance. Specifically, a method combining normative analysis and case comparison is employed. Through normative analysis, it explores how blockchain technology, leveraging features like decentralization, immutability, and traceability, addresses issues such as information silos, difficulties in credit transmission, and high risk control costs faced by traditional supply chain finance, constructing a theoretical framework for SME financing. In the comparative analysis section, it examines the changes in credit transmission efficiency, risk control mechanisms, and financing costs before and after the introduction of blockchain technology, demonstrating its practical effects through typical cases. Theoretically, this study elucidates how blockchain reshapes credit transmission and risk management mechanisms in supply chain finance. Practically, it proposes actionable transformation strategies for financial institutions and various stakeholders in the supply chain.

2. Financing status of SMEs in China and supply chain finance development

2.1. Financing dilemmas and challenges for SMEs

As a vital pillar of China's real economy, SMEs contribute more than 50% of tax revenue, 60% of GDP, and 80% of employment. However, these enterprises have long faced financing challenges. According to the Ministry of Industry and Information Technology, about 33% of medium-sized enterprises and 40% of SMEs are unable to have their financing needs met. The issue stems from the combined effects of information asymmetry, high transaction costs, and credit rationing. Based on the theory of information asymmetry, SMEs generally suffer from a lack of "hard information." Irregular financial statements, incomplete operational data, and insufficient collateral assets make it difficult for banks to accurately assess their credit risks, leading to adverse selection. In particular, technology- and service-oriented SMEs often lack qualified collateral, making it difficult to access traditional finance. Besides, transaction cost theory shows that banks face higher credit approval and post-loan management costs for SMEs compared to large enterprises. The characteristics of SMEs, such as small loan amounts per transaction and frequent financing needs, further drive up transaction costs. Credit rationing theory indicates that when interest rates are regulated or risk pricing capabilities are inadequate, banks selectively reject loan applications from some SMEs, even if the latter are willing to pay higher interest rates. In the supply chain context, this financing challenge is even more pronounced. Small suppliers, often at the end of the supply chain, face extended accounts payable periods from core enterprises (typically 90-180 days), leading to a large buildup of receivables. Although based on real transactions, low liquidity and financing barriers worsen liquidity pressure on SMEs, creating a cycle where the strong thrive and the weak struggle.

2.2. The value and role of supply chain finance

The emergence of supply chain finance offers a market-driven solution to the financing challenges. Its core principle lies in shifting the focus of credit assessment for financing from the "entity credit" of individual enterprises to the "transactional" or "asset credit," grounded in real trade activities. Unlike traditional credit models, which rely on corporate financial data and collateral guarantees, supply chain finance validates the authenticity of transactions through commerce, logistics, capital,

and information flow, using the creditworthiness of core enterprises to provide financing for their partners. Specifically, supply chain finance revitalizes existing assets through accounts receivable financing, alleviates procurement pressure with prepayment financing, and activates static assets through inventory financing [1]. For example, in accounts receivable financing, a core enterprise boosts the financing capacity of its upstream suppliers through credit endorsement, allowing SMEs to turn receivables into liquid assets. This model overcomes the limitations of information asymmetry, as core firms have deeper insights into their supply chain partners' operations and transactions. As a result, their commitment to payment transforms accounts receivable into high-quality, financeable assets. Data indicates that supply chain finance can improve the financing efficiency for small and micro enterprises by 40%, reducing approval times from the traditional 2-4 weeks to just 3-5 days [2]. By 2020, the scale of China's supply chain finance market had reached 15 trillion yuan, serving over 23.6 million small and micro enterprises, making it a crucial avenue for alleviating financing difficulties. Theoretically, supply chain finance enables a shift in risk control logic. By creating a closed-loop ecosystem within the supply chain, it converts the fragmented risks of small and micro enterprises into manageable overall credit and transaction risks. For banks and other capital providers, the focus of risk control shifts from assessing individual small and micro enterprises to evaluating the transactional health of the core enterprise and its supply chain, reducing information acquisition costs and the difficulty of risk identification.

2.3. Major challenges of traditional supply chain finance

The supply chain finance, meant to address traditional financing challenges, has not fully realized its potential, particularly in accounts receivable factoring. The following four core pain points have been exposed. First, information silos and high verification costs. Bank, enterprise, and supplier systems are disconnected, with critical data scattered across formats, requiring banks to invest heavily in offline verification of transaction authenticity and receivable ownership. This process is time-consuming, labor-intensive, and still struggles to eliminate fraud risks. Second, limited credit transmission. In the traditional model, the credit of core enterprises can only cover their direct first-tier suppliers. While accounts receivable held by first-tier suppliers against core enterprises are relatively easy to finance, those held by second-tier, third-tier, and more downstream suppliers struggle to secure financing support. Third, cumbersome operational processes and significant risks. Factoring financing involves steps like notifying accounts receivable assignment, confirming rights, registering in the People's Bank of China's Unified Registration and Publicity System for Movable Property Financing, as well as disbursement and repayment. These steps heavily rely on manual operations and paper documents, leading to both low efficiency and increased operational and moral risks. Incidents such as duplicate financing, where the same account receivable is repeatedly ledged or transferred across different financial institutions, and fraudulent trade financing are common. Fourth, data privacy and collaboration conflicts. While all parties in the supply chain wish to share data to enhance overall efficiency, they are also concerned about the leakage of critical business information, such as pricing, transaction volumes, and customer lists. The lack of reliable technical safeguards makes deep data sharing difficult, resulting in a dilemma of "unwillingness to share, fear of sharing."

3. The mechanism and pathway of blockchain empowering supply chain finance

3.1. Blockchain technology architecture and core mechanisms

Blockchain technology provides a novel trust mechanism for supply chain finance via its distributed ledger architecture [2]. Its core lies in linking data blocks sequentially using timestamp technology to form an immutable chain structure, ensuring data security and consistency. Blockchain also adopts asymmetric encryption algorithms to protect data transmission and relies on consensus mechanisms like PBFT and DPOS to synchronize data across all nodes, reducing reliance on intermediaries and trust risks [1]. In supply chain finance, smart contracts serve as a critical application of blockchain technology. They can automatically execute transaction operations when predefined conditions are met. For example, smart contracts can automatically trigger repayment instructions when accounts receivable reach maturity, thereby eliminating risks associated with human intervention. To better protect commercial privacy, supply chain finance commonly adopts consortium blockchain models, enabling data sharing while limiting access to information. For example, AntChai's Double-Chain Link platform uses a consortium blockchain to connect core enterprises, suppliers, and financial institutions, enabling end-to-end visual supply chain finance management [3].

3.2. Digital credit certificates and supply chain credit flow

By digitizing and tokenizing core enterprises' payables, debt instruments and multi-level credit circulation overcome traditional financing challenges, hence enhancing credit circulation efficiency. Specifically, based on genuine transactions, a core enterprise issues a digital debt instrument on a blockchain platform [4]. This instrument records key elements such as amount, term, and creditor, and is validated through digital signatures. Once issued, the instrument is immutable. Upon receiving the instrument, the first-tier supplier can choose to split and transfer it to downstream suppliers (second-tier suppliers), a process that can extend to N-tier suppliers. Each split and transfer is fully recorded by the blockchain system, ensuring clear ownership and traceability [5].

Through this mechanism, suppliers holding digital instruments can apply for financing at any time from financial institutions connected to the platform. Financial institutions provide financing based on the core enterprise's payment commitment. Upon maturity, smart contracts automatically execute the core enterprise's payment instructions, and funds are settled reversely along the supply chain to holders at each level. For example, SF Express's "Rongyi Chain" platform utilizes this mechanism, where electronic instruments for accounts receivable are automatically generated after the core enterprise confirms receipt of goods. And first-tier suppliers can transfer or pledge these instruments to second-tier suppliers, spreading credit across multiple tiers and helping small and micro enterprises access low-cost financing. Data shows that blockchain technology has increased credit circulation efficiency by over 50%, reducing financing turnaround time from the traditional two weeks to less than 24 hours. China Zheshang Bank's Accounts Receivable Chain Platform allows unlimited splitting of instruments, with each accounts receivable instrument able to be split up to 1,000 times. The number of small and micro enterprises served grew by 300% year-on-year. In traditional factoring, second-tier suppliers struggle to obtain financing. Platforms like Tencent Cloud's "Weiqi Chain" or "Zhongqi Yunlian" allow digital instruments from an automotive group to circulate across tiers, enabling screw suppliers to access low-cost financing within hours.

3.3. Bank-enterprise trust and financing efficiency optimization

Blockchain fundamentally reshapes the trust relationship between banks and enterprises by creating a "trusted data pool." Information like orders, contracts, invoices, and logistics documents within the supply chain is recorded on the chain after confirmation by all parties, ensuring data consistency, immutability, and end-to-end traceability [6]. Banks can verify transaction information without relying on paper documents or third-party intermediaries. Instead, they can verify trade data efficiently on-chain, eliminating information asymmetry.

This reduction in trust costs drives greater financing efficiency. Firstly, blockchain's automated verification mechanism greatly reduces banks' risk control costs. In traditional financing models, credit assessment, compliance checks, and other processes require extensive manual intervention. Blockchain technology automates these stages through smart contracts, lowering labor costs and speeding up the review process [7]. Secondly, smart contracts automate financing, reducing costs and streamlining processes. Lastly, blockchain boosts transaction transparency and risk controllability, enabling financial institutions to assess risks more accurately, which in turn lowers risk premiums [8]. This allows small and micro enterprises to access financing at lower interest rates. Furthermore, blockchain technology significantly shortens the financing cycle, reducing it from the traditional several weeks or even months to just hours or even minutes, thereby greatly enhancing the capital turnover efficiency of enterprises [9].

3.4. Data sharing and privacy security balance

Blockchain balances data sharing and privacy through innovation. Supply chain finance blockchain typically adopts a consortium architecture, where only authorized participants, like core enterprises, suppliers, financial institutions, and logistics companies, can become nodes and access the network, thereby ensuring privacy boundaries at the entry point. Meanwhile, blockchain technology utilizes privacy-preserving computational techniques like zero-knowledge proofs, enabling participants to prove information authenticity without exposing the original data content [10]. For instance, it can be demonstrated that the amount of accounts receivable exceeds 1 million RMB and has not been used for duplicate financing, without disclosing specific transaction amounts or detailed cargo data, thus achieving "data usability without visibility." Moreover, enterprises control their own data through private keys and can precisely manage data access permissions. This ensures that each instance of data usage and circulation is accompanied by explicit authorization records, with full traceability throughout the process, mitigating the risk of data misuse. Through these mechanisms, blockchain boosts data collaboration and efficiency in supply chain finance, ensuring privacy protection.

4. Policy recommendations and development pathways

To promote the healthy growth of blockchain-based supply chain finance, regulators should speed up the development of technical, data, and security standards for blockchain in finance. This will offers a clear innovation framework and ensure compliance. And the proactive promotion of the "regulatory sandbox" mechanism is essential to encourage innovative models within a controlled environment, offering the industry room for experimentation and adjustment. Most critically, it is imperative to clarify the legal attributes of digital debt instruments and their validity as electronic evidence in a timely manner. At the same time, financial institutions must shift their mindset from the traditional "collateral-heavy" financing model to a new paradigm that places greater emphasis on

"data credit." They should actively collaborate with technology companies and industry leaders to jointly establish or access mature consortium blockchain platforms, thus enhancing their digital service capabilities for industrial chains and their innovation in financial products. Core enterprises should understand that the digitalization of supply chain finance represents both a demonstration of social responsibility and a strategic move to strengthen the overall competitiveness and resilience of the industrial chain. And they should proactively open data, actively embrace digital platforms, and take the lead in building and driving the industrial digital finance ecosystem to advance the digital transformation of the entire supply chain. Furthermore, technology companies must continuously tackle underlying technical challenges, improve the performance, cross-chain interoperability, and privacy protection capabilities of consortium blockchains, and provide more stable, user-friendly, and compliant technological solutions. This will facilitate the implementation of digital innovations in supply chain finance.

5. Conclusion

This study analyzes the mechanisms and pathways through which blockchain technology empowers supply chain finance. The findings indicate that blockchain enables the multi-level circulation of digital debt instruments, facilitating the penetration and transmission of credit from core enterprises, thereby allowing end-level small and micro enterprises to benefit from this credit. By constructing a trusted data pool maintained by multiple parties, blockchain significantly reduces information asymmetry and risk control costs. Besides, through privacy-preserving computation and permission management, it promotes collaboration while ensuring data security. In essence, blockchain shifts supply chain finance from the traditional "entity credit" model to a digital trust framework based on "programmable transaction credit."

Nevertheless, comprehensive adoption still faces multiple challenges. On the technical front, the performance of consortium blockchains, cross-chain interoperability, and the maturity of advanced privacy-preserving technologies require further improvement. On the operational side, the success of the model heavily depends on the willingness and commitment of core enterprises to take the lead. From a regulatory perspective, issues like the legal status of digital debt instruments and smart contract enforceability need urgent standardization. In the future, blockchain-driven supply chain finance will move toward greater integration and intelligence. On one hand, by combining with technologies such as the IoT and artificial intelligence, it will achieve a trusted "physical-digital" closed loop and dynamic risk control. On the other hand, its functions will expand from financing to payment, asset management, and supply chain collaboration, further evolving into a digital financial infrastructure that enhances the resilience of industrial chains.

References

[1] Chen, J. (2019). Research on the optimization of supply chain finance services based on blockchain technology. Guangdong University of Finance & Economics.
[2] Li, X. (2024). The impact of blockchain-enabled supply chain finance on financing for private enterprises. Jilin University of Finance and Economics.
[3] Peng, C. (2023). An exploration of the application effects of Ant Group's dual-chain "Blockchain + Supply Chain Finance" platform. Xiangtan University.
[4] Liu, Z. (2020). Literature review of supply chain finance based on blockchain perspective. Open Journal of Business and Management, 9(1), 419-429.
[5] Panisi, F. (2017). Blockchain and'Smart Contracts': FinTech Innovations to Reduce the Costs of Trust. Available at SSRN 3066543.

[6] Wang, M. (2016). Research on the evolution of supply chain finance mode in the â Internet+â era. Open Journal of Social Sciences, 4(3), 130-136.

[7] Chowdhury, M. U., Suchana, K., Alam, S. M. E., & Khan, M. M. (2021). Blockchain application in banking system. Journal of Software Engineering and Applications, 14(7), 298-311.

[8] Budisteanu, T. G. (2025). Blockchain and the Banking Sector: Benefits, Challenges and Perspectives. Open Journal of Social Sciences, 13(3), 288-300.

[9] Haiwu, H., An, Y., & Zehua, C. (2018). Survey of smart contract technology and application based on blockchain. Journal of Computer Research and Development, 55(11), 2452.

[10] Li, Z. (2022). A verifiable credentials system with privacy-preserving based on blockchain. Journal of Information Security, 13(2), 43-65.