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Blockchain-Driven Trust Architecture in Multi-Tier Supply Chains: Reshaping Financing Strategies from Manufacturers to Distributors and E-Commerce Platforms

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Abstract

In supply chain finance (SCF), the long-standing issue of "difficult and expensive financing" has hindered SMEs' growth, with blockchain technology offering a novel solution. This study adopts a theoretical framework of supply chain internal and external financing to systematically analyze financing models: internal financing for upstream manufacturers, midstream distributors, and downstream e-commerce enterprises, and external bank financing via blockchain platforms. It compares decision-making differences between traditional and blockchain-enabled financing, revealing that blockchain technology reshapes the financing landscape through three core mechanisms: information sharing via distributed ledgers, credit transmission across supply chain tiers, and cost optimization through smart contracts. The study finds that blockchain reconstructs the trust system, optimizes banks' risk pricing, and alleviates financing constraints for end-tier enterprises. Additionally, platforms dominated by different entities (e.g., manufacturers, e-commerce companies, and banks) reshape supply chain pricing and profit distribution through differentiated governance rules. These findings provide theoretical support for integrating "blockchain + SCF" and guide supply chain members in optimizing financing decisions and technology adoption strategies.

Keywords: Blockchain, Supply Chain Financing, Credit Transmission, Information Sharing, Cost Optimization

Introduction

As a key bridge between the real economy and financial services, SCF has played an increasingly important role in solving the financing difficulties of small and medium-sized enterprises in recent years. However, the traditional SCF model still faces many structural challenges: high risk premiums caused by information asymmetry, credit transmission

mechanisms limited to direct transaction relationships, low financing efficiency, and narrow coverage (Wu et al., 2024). This dilemma of "difficult and expensive financing" has become a key bottleneck restricting the healthy development of the supply chain. The emergence and evolution of blockchain technology have brought a new paradigm shift to SCF.

Blockchain's distributed ledger, consensus mechanisms, and smart contracts fundamentally reconstruct SCF operations (Turjo et al., 2021). However, current research lacks systematic frameworks and predominantly examines single financing relationships, failing to address critical issues: 1) blockchain-enabled credit transmission in multi-tier supply chains (MTSC) (Chu et al., 2024); 2) financing ecosystem evolution under different core members (manufacturers, banks, e-commerce platforms) (Wen et al., 2021); 3) intrinsic links between information sharing and value creation (Russo-Spena et al., 2022).

Based on the above research background and problems, this study aims to construct an integrated theoretical framework, systematically analyze the impact mechanism of blockchain technology on internal and external financing decisions of the supply chain, and explore the evolution path and decision-making differences of different financing models before and after blockchain empowerment.

At the theoretical level, it reveals that blockchain fundamentally changes the decision-making logic of supply chain financing by reshaping the information structure (distributed ledger), the credit transmission mechanism (cross-level penetration), and the value distribution model (smart contract); At the decision-making level, compare and analyze the decision-making differences of upstream, midstream and downstream enterprises and banks under the traditional and blockchain financing models, and identify the key factors influencing the selection of financing channels (such as information transparency and credit transfer efficiency); At the application level, this paper explores the differentiated impacts of blockchain platforms led by different entities such as manufacturers, e-commerce platforms, and banks on the financing ecosystem, providing strategic guidance for enterprises' technology adoption and platform governance.

The innovation of this study is mainly reflected in four aspects: First, the innovation of the theoretical framework. Compared with the research of Ma et al. (2024), an integrated theoretical framework of internal and external financing of the supply chain under blockchain empowerment was constructed, and the core mechanism of blockchain technology to reconstruct supply chain financing decisions was systematically explained. Second, the innovation of the research perspective broke through the limitations of a single financing relationship or a single application scenario in traditional research, and comprehensively examined the differentiated impact of blockchain technology from the perspective of three financing relationships (Wang et al., 2022). Third, the innovation of the analytical dimension. Compared with the research of Song et al. (2023), the traceability and anti-counterfeiting functions of blockchain were organically combined with supply chain financing decisions, revealing the dual value creation mechanism of technology empowerment. Fourth, the innovation of the application scenario. Compared with the research of Zhu et al. (2023), the differentiated effects of different core enterprises in building blockchain platforms were deeply analyzed, providing contextual guidance for the technology adoption of enterprises.

Based on this, this study will be carried out according to the following logic: Chapter 2 reviews the research progress in the intersection of SCF, blockchain technology, and supply chain management, and analyzes the theoretical and practical limitations of existing research. Chapter 3 constructs a theoretical model from three dimensions: upstream manufacturer financing, midstream dealer financing, and downstream e-commerce enterprise financing, analyzes the impact mechanism of blockchain technology on financing decisions, and refines the four core mechanisms of technology empowerment. Chapter 4 explores the implications of research findings for supply chain governance and financial practices from a management perspective and proposes future research directions. Chapter 5 summarizes the research conclusions and provides targeted suggestions for enterprise technology adoption and policy formulation.

Literature Review

SCF

SCF integrates financial tools to optimize liquidity and operational efficiency across supply chains. Uddin and Habib (2023) critique existing frameworks for overlooking systemic barriers, such as SMEs' limited access to advanced SCF solutions. Digital transformation has revolutionized SCF through fintech innovations like blockchain and AI. Xu (2023) highlights how digital tools improve resource allocation for SMEs, and Kommula (2025) advocates AI-driven analytics for smarter financing decisions. Blockchain's transparency benefits are lauded (Abdullah et al., 2024), but Chen and Liu (2023) warn of vulnerabilities in decentralized systems, such as smart contract loopholes and regulatory ambiguities. Despite these advancements, adoption remains uneven due to SMEs' technological literacy gaps and fragmented regulatory environments, raising questions about the scalability of digital SCF models.

Meanwhile, SCF's benefits are counterbalanced by risks and implementation challenges. Qiao and Zhao (2023) stress that financing constraints and poor risk management can destabilize SMEs, while Mao et al. (2024) argue that current SCF frameworks lack robust risk-assessment tools to address economic volatility. Sustainability integration, though promising, faces skepticism. Edunjobi (2024) positions banks as key drivers of SCF, but critics note a disconnect between theoretical models and real-world implementation, particularly in agriculture (Li & Sutunyarak, 2023). Liu (2024a) links SCF to eco-innovation, yet questions persist about whether "green" financing genuinely reduces environmental impact or merely serves as corporate greenwashing. Adoption barriers—complex regulations, SME awareness gaps, and reliance on traditional banking (Fan et al., 2023)—further hinder progress. Xia et al. (2023) propose machine learning to mitigate credit risks, but their models assume data accessibility, a luxury many SMEs lack. Future research must address these contradictions, particularly how decentralized finance and circular economy principles can reconcile SCF's financial and sustainability goals (S. Owolabi et al., 2024).

Blockchain-enabled SCF

Blockchain technology reconstructs the fundamental trust mechanism in SCF through distributed ledgers and smart contracts, offering a technological solution to the information silos plaguing traditional models. Existing research demonstrates that its immutability and real-time traceability significantly reduce transaction verification costs (Guo et al., 2024), while smart contracts' automated execution not only eliminates intermediaries (Huang &

Gan, 2023) but also enables credit penetration across multi-tier suppliers through on-chain data. This breakthrough allows SMEs to transcend the "relationship radius" constraints of traditional financing (Bhatia et al., 2023). However, this techno-optimistic narrative overlooks power dynamics in organizational adoption: blockchain platforms dominated by core enterprises may exacerbate supply chain bargaining power imbalances, with current literature failing to systematically examine value distribution conflicts under different governance models involving manufacturers, banks, and e-commerce platforms (Dong & Zhang, 2023).

Studies reveal a dual effect of blockchain on SCF resilience. On one hand, real-time data sharing enhances risk prediction capabilities, where smart contracts' dynamic response mechanisms mitigate liquidity crises during external shocks like pandemics (Grida & Mostafa, 2022). On the other hand, technological rigidity may undermine supply chain flexibility—algorithmic credit assessments could amplify systemic risks when on-chain data deviates from physical realities (Li & Qu, 2023). This paradox is pronounced in sustainable finance: while carbon footprint tracing facilitates green financial innovation, blockchain's high energy consumption conflicts with sustainability goals, with existing research yet to establish quantitative models linking technical optimization pathways to ecological benefits.

Research Gaps

Although existing research has initially explored the application value of blockchain technology in SCF, there are still three key gaps: first, most studies only focus on the impact of blockchain technology on a single financing model, lacking a systematic comparison of the differentiated impact of different financing models; second, the research perspective is often limited to the technical application level, ignoring how blockchain fundamentally reconstructs the power structure and interest distribution mechanism of the supply chain; third, existing research pays less attention to the intrinsic connection between the traceability and anti-counterfeiting functions of blockchain and financing decisions, making it difficult to fully grasp the value creation path of blockchain technology.

Based on the progress and shortcomings of existing research, this study aims to construct an integrated theoretical framework to systematically analyze how blockchain technology fundamentally changes the logic of internal and external financing decisions in the supply chain by reshaping the information structure, credit transmission mechanism and value distribution pattern, and fill the key gaps in existing theoretical research.

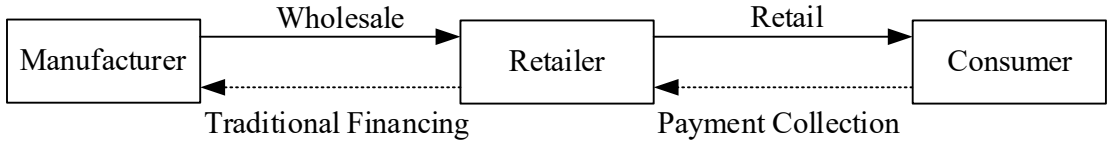
Theoretical Modeling of Blockchain in Supply Chain Financing

This chapter develops a systematic framework to examine how blockchain technology reshapes supply chain financing through information and credit mechanism reconstruction. By analyzing three typical financing relationships, it reveals the core impact mechanisms and value creation paths of blockchain on internal and external financing decisions.

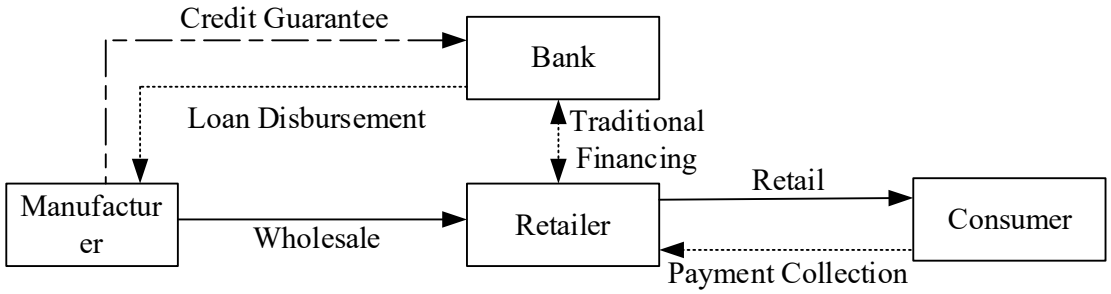
Financing of Upstream Manufacturers Based on Blockchain Platform

As the basic starting point of the research, this section constructs a two-level supply chain financing system consisting of manufacturers (core enterprises, sufficient funds), retailers (fund constraints), and banks. Under this framework, retailers, unable to settle the full purchase amount due to funding constraints, need to explore financing solutions. Depending

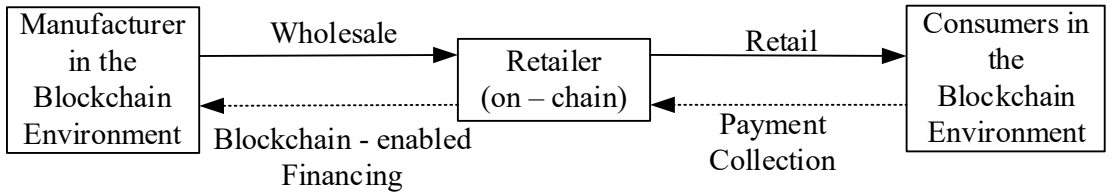
on whether the manufacturer has built a blockchain platform and the differences in the payment methods of retailers, four financing scenarios can be identified: traditional upstream manufacturer financing, traditional bank financing, upstream manufacturer financing based on the blockchain platform, and bank financing based on the blockchain platform, as shown in Figure 1.



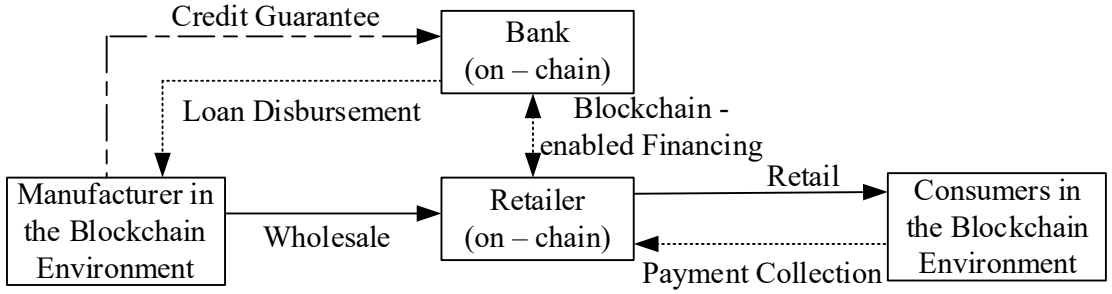
(1) Traditional Upstream Manufacturer Financing



(2) Traditional bank financing



(3) Upstream manufacturer financing based on blockchain platforms



Bank financing based on blockchain platforms (4)

Figure 1: Upstream Manufacturer and Bank Financing Models

The theoretical analysis is based on the following core assumptions: the blockchain platform mainly provides information sharing and traceability, and anti-counterfeiting functions; manufacturers are responsible for platform construction and operation; the blockchain traceability function has a positive incentive on market demand.

Blockchain technology reshapes upstream financing mechanisms through dual pathways of information transparency and value enhancement, revolutionizing the trust foundation and value logic of traditional supply chains (Lee & Zhang, 2023). This aligns with the finding that digital tools reduce operational costs for SMEs (Nor et al., 2021), but blockchain goes beyond by automating trust through smart contracts and enabling cross-tier cost optimization—key features absent in traditional digital solutions.

Traditional financing relies on isolated data storage systems where fragmented and easily manipulated information between entities forces banks to depend on credit endorsements from core enterprises, resulting in high financing costs due to information asymmetry. Blockchain addresses this through distributed ledgers that enable real-time data sharing and immutability. Banks can directly verify transaction records on-chain, assessing retailer creditworthiness based on authentic transaction histories. This fundamentally reduces information asymmetry and risk premiums, establishing a technology-driven trust system.

Moreover, blockchain's product traceability and anti-counterfeiting features generate spillover value: Full-chain data transparency strengthens consumer trust, boosting brand credibility and product repurchase rates, thereby indirectly optimizing corporate financing credibility. The trustworthy on-chain records also empower SMEs to break through traditional financing's "relationship barriers," enabling them to secure fairer financing opportunities using authentic transaction data. This technological empowerment not only enhances financing efficiency but also restructures supply chains' value distribution logic through data association, creating long-term competitive advantages for upstream and downstream.

In the traditional supply chain financing model, the decision-making logic between manufacturers, retailers, and banks is subject to the rigid constraints of information monopoly and credit transmission. As shown in Figure 1, in the traditional financing model (1) (2), manufacturers dominate credit guarantee and capital allocation by their core position, forming a financing system centered on “entity control”: manufacturers provide internal financing to retailers through delayed payment or credit endorsement (model 1), or promote banks to intervene in prepaid account financing through guarantee agreements (model 2). However, this one-way credit flow causes the capital-constrained party (retailer) to fall into a passive choice – its financing channels are limited by the credit capacity of manufacturers and the trust threshold of banks, and the financing cost is double-premiered (risk premium and bargaining premium) due to information asymmetry. The intervention of blockchain technology (models 3 and 4) triggers a paradigm shift in the logic of financing decision-making by reconstructing the interactive relationship of “information-credit-capital”.

First, blockchain technology deconstructs the power monopoly of traditional credit intermediaries and reshapes the basis of financing decisions. In the traditional model, the irreplaceable nature of manufacturers as credit intermediaries stems from their exclusive control over supply chain transaction data (e.g., the credit guarantee in Model 1 relies on the manufacturer’s verification of the authenticity of the order). The blockchain platform (models 3 and 4) converts transaction data (such as purchase orders, logistics records, and sales returns) into public certificates that can be verified on the chain through distributed ledgers, enabling banks to independently verify the authenticity of the trade background and reduce their reliance on the manufacturer’s credit endorsement (Ghosh, 2015). This shift directly

shakes the manufacturer's bargaining power in the financing system, as shown in Figure 1, Model 4. When banks directly participate in prepaid account financing through on-chain data, the manufacturer's role degenerates from a "credit monopolist" to a "data provider" (Deng et al., 2021). At this point, the manufacturer needs to attract retailers to use its dominant blockchain platform by lowering wholesale prices (strategy adjustment in model 3) to maintain control over the supply chain. The essence of this decision adjustment is that the core enterprise shifts from "controlling credit flow" to "operating data flow", marking the decentralized reconstruction of financing power.

Second, information transparency reconstructs the calculation logic of financing costs and promotes the decision-making criteria from "static interest rate comparison" to "dynamic risk hedging". In the traditional model, the core basis for retailers to choose financing channels is the interest rate level (the manufacturer financing rate in model 1 and the bank financing rate in model 2). However, in the blockchain environment (models 3 and 4), the traceability and immutability of on-chain data significantly reduce the bank's post-loan supervision costs and default risk expectations. As shown in Figure 1, Model 4, banks can upgrade the fixed interest rate model in traditional financing to a dynamic risk pricing model (such as adjusting the interest rate based on real-time inventory turnover) by real-time tracking of on-chain logistics and sales data (Pan, 2017). This shift makes retailers face a more complex decision function: in addition to the interest rate level, the potential value of on-chain data (such as reducing future financing costs through data sharing) and the technology lock-in period (such as the constraints of the platform usage agreement) must also be considered. For example, when the blockchain platform provides full-link data of the supply chain (model 4), retailers may accept a slightly higher bank interest rate in exchange for long-term data asset accumulation, thereby breaking through the short-term cost-oriented logic of traditional financing decisions. Third, the blockchain platform catalyzes the expansion of the supply chain value network, driving the evolution of financing decisions from "zero-sum game" to "ecological co-construction". In traditional financing models (1, 2), the distribution of interests among manufacturers, retailers, and banks presents a competitive relationship of one rising and the other falling (for example, manufacturers squeeze retailers' profits through high wholesale prices and financing service fees). However, the blockchain platform (models 3 and 4) binds the interests of multiple parties under the same technical framework through smart contracts, forming a collaborative mechanism based on data sharing. As shown in Figure 1, Model 3, when the manufacturer dominates the blockchain platform, it can attract retailers to join the chain by lowering wholesale prices, and then obtain lower-cost funding support from banks with on-chain data as collateral, achieving a win-win situation for all three parties. The deeper change lies in the credit transmission function of the blockchain (the credit flow in the figure changes from one-way to mesh), which extends the scope of influence of financing decisions from a single-level supply chain to a multi-level ecosystem. For example, the blockchain platform dominated by manufacturers can "penetrate" its credit to secondary suppliers through smart contracts, prompting banks to provide financing to multi-level suppliers based on the credit of core enterprises (not shown in the figure but implied in the scalability of model 3). This ecological decision-making logic requires participants to evaluate the long-term value of technology adoption from a global perspective, rather than being limited to cost-benefit analysis of local transactions.

In summary, blockchain technology promotes the transition of supply chain financing decisions from "power-driven" to "data-driven" by deconstructing credit monopoly, reconstructing risk pricing models, and expanding value networks. In this process, the deep integration of technical characteristics and business logic is reshaping the underlying rules and top-level design of SCF.

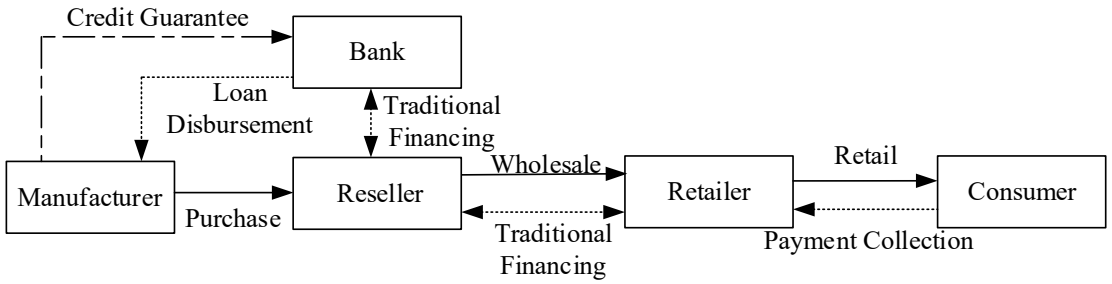
Financing of Midstream Distributors Based on Blockchain Platform

Based on the financing structure in the previous section, we introduce distributors. This section analyzes the dual funding constraints of distributors and retailers in a multi-level supply chain. Traditional SCF faces a "credit transmission dilemma" – the credit guarantee of the core enterprise usually only covers the first-tier suppliers with direct transactions. The multi-level enterprises at the end of the supply chain have difficulty obtaining effective financing support due to the lack of direct transaction relationships with the core enterprise. This "long tail effect" leads to insufficient financing coverage of the overall supply chain, which restricts the efficiency of coordination. As shown in Table 1, the difficulties of traditional multi-level supply chain financing are manifested in three main aspects:

Table 1
Dilemma of traditional multi-level supply chain financing

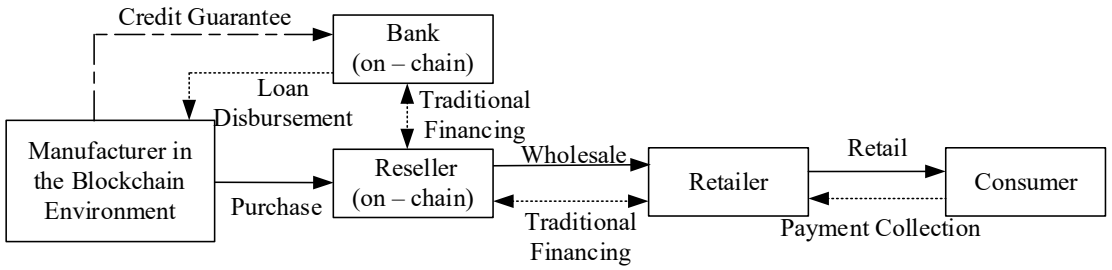
Challenge Type	Manifestation	Impact
Financing Scale Preference	Banks prefer large-scale financing for tier-1 distributors, neglecting small-scale financing for end retailers.	Financing resources concentrate upstream, leaving downstream SMEs preserved.
Lack of Transaction Visibility	Cross-tier enterprises lack transaction transparency and trust; core firms struggle to validate indirect transactions.	Credit endorsement chains break down, disrupting trust transmission mechanisms.
Escalating Risk Costs	Credit investigation costs and default risks grow exponentially with supply chain tiers.	Excessively high financing costs for downstream firms ("high-cost financing").

This section constructs a three-level supply chain financing system consisting of manufacturers (core enterprises, sufficient funds), distributors (fund constraints), retailers (fund constraints), and banks. Under this framework, manufacturers rely on their core position to require distributors to pay for purchases promptly and provide credit guarantees. Distributors and retailers also face funding constraints and need to solve the problem of funding liquidity through financing channels. The main body of the blockchain platform may be manufacturers or banks, forming different governance structures and value distribution patterns. According to the construction of the blockchain platform and the choices of all parties to go online, three financing models can be identified: traditional internal and external hybrid financing, internal and external hybrid financing based on the manufacturer's blockchain platform with dealers going online, and bank financing based on the manufacturer's blockchain platform with retailers going online, as shown in Figure 2.

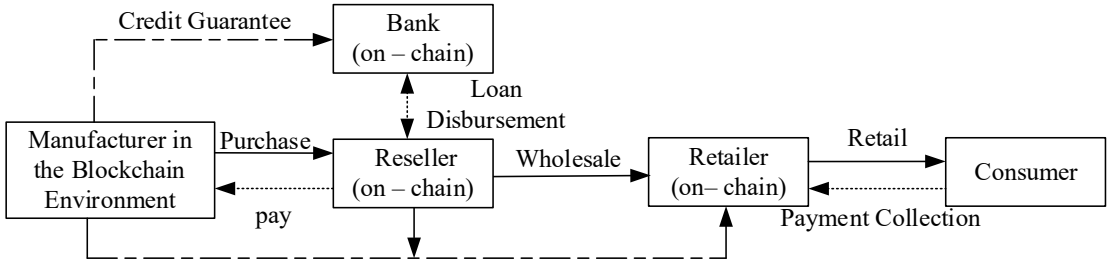


(1) Traditional Hybrid Internal-External Financing (Distributor & Bank)

(2)



(3) Mixed internal and external financing for dealers going on chain (with some enterprises going on chain)



(4) Bank financing for retailers going online (all enterprises going online)

Figure 2: Midstream Distributor and Bank Financing Models Based on Manufacturer's Blockchain Platform

Traditional multi-level supply chain financing is affected by information silos and trust barriers, and credit transmission often stops at first-level distributors. As shown in Model (1) in Figure 2, the manufacturer, Reseller, and Retailer rely on the traditional financing model. The bank needs to lend to the Reseller through the credit guarantee of the manufacturer, and the end Retailer has difficulty obtaining financing due to the opaque transaction information. This hierarchical structure leads to the supply chain's heavy reliance on intermediate links, and the overall collaborative efficiency and risk resistance capacity are weak. Blockchain technology solidifies multi-level transaction data (such as purchase orders and logistics vouchers) onto the chain in a time series through a distributed ledger, forming a cross-level "digital credit chain". In Mode (2), after the Reseller is on-chain, the manufacturer and the bank interact based on on-chain data, and the transparency of credit transmission is significantly enhanced. Although Retailer still partially relies on traditional financing channels, the on-chain data of Reseller has enabled the automatic verification of the authenticity of primary transactions, and the supply chain structure has transitioned from a highly hierarchical to a slightly flattened one. Model (3) further realizes the full on-chain operation

of Reseller and Retailer, transforming the capital flow from the circuitous path of "retailer → distributor → bank" to a direct "end-to-end" connection. Historical transaction records on the chain can automatically link the indirect transaction relationships between secondary suppliers (such as retailers) and manufacturers, generating quantitative credit certificates, enabling banks to break through the traditional "credit truncation" strategy and directly provide financing for end enterprises. This "network penetration" type of transmission breaks the "level attenuation" effect of credit transmission for instance, secondary suppliers can independently apply for financing based on on-chain transaction records without relying on the credit endorsement of primary distributors, and the financing coverage expands from one level to multiple levels. From the perspective of risk governance, blockchain records the data of the three flows of "transaction flow, capital flow, and logistics" in real time, and builds a full-chain credit monitoring network. When abnormal conditions such as payment delays occur at a certain level, the smart contract automatically triggers risk warnings, freezes the financing rights of related parties, and traces the source of risks through on-chain data, achieving "risk penetration management" (Liu, 2024b). Compared with the risk control blind spots caused by the traditional model relying on manual due diligence, blockchain technology significantly reduces the post-loan supervision cost, strengthens the technical constraint mechanism of credit default, and promotes the evolution of the supply chain from "fragile connection" to "elastic ecosystem". By comparing the three models, it can be seen that in the traditional model (1), due to the opacity of information, the credit transmission is limited to one level, and the structure is rigid and hierarchical; Mode (2) optimizes the efficiency of primary credit transmission through partial on-chain operation and has a slightly flat structure. Mode (3) achieves cross-level credit penetration and networked allocation of capital flow through full-chain data interaction, fundamentally reconstructing the credit transmission mechanism and risk governance framework of SCF. This evolution not only expands the coverage of financing but also promotes the transformation of the supply chain structure from a "quota system dominated by core enterprises" to a "data-driven market-oriented allocation", providing a technology-enabled path for solving the problems of "difficult and expensive financing" for small and medium-sized enterprises.

Financing of Downstream E-Commerce Enterprises Based on Blockchain Platform

The rapid development of e-commerce has provided retailers with new sales and financing channels. In the previous two sections, it was assumed that the internal financing of the supply chain was provided by upstream enterprises and in the form of deferred payment. This section will introduce e-commerce enterprises downstream of retailers with capital constraints and analyze the supply chain financing scenario where internal financing is provided by e-commerce enterprises downstream of retailers and the financing interest rate is endogenous.

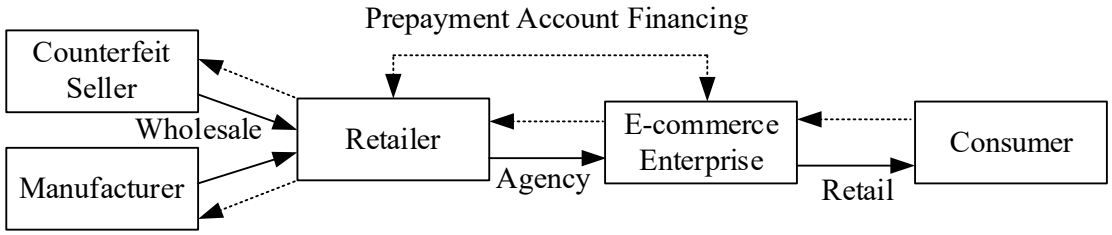
As shown in Table 2, as a special node in the supply chain, e-commerce companies are not only sales platforms, but also play the role of financing service providers, forming a financing model with three unique characteristics:

Table 2
E-commerce enterprise financing characteristics

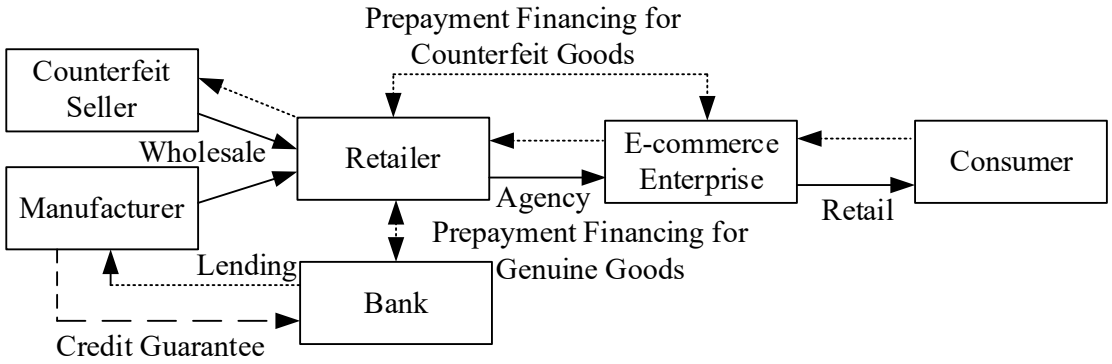
Feature Dimension	Characteristic Manifestation	Distinction from Traditional Financing
Uniqueness of Financing Structure	E-commerce enterprises are positioned downstream of retailers, forming a "reverse financing" structure.	Alters the traditional direction of capital flow in supply chains.
Operational Efficiency of Financing	Features "rapid disbursement" and "direct fund allocation" mechanisms.	Resembles bank financing models more closely than traditional delayed payment systems.
Dual Role Integration	Simultaneously acts as both a sales channel and a financial service provider.	Combining the advantages of internal financing relationships with the professional efficiency of external financing.

This section constructs a supply chain financing system consisting of manufacturers, counterfeiters, capital-constrained online retailers, e-commerce companies, and banks. In the e-commerce environment, the problem of counterfeit goods is an important factor affecting consumer trust and market order. Online retailers sell goods through e-commerce companies, but they are unable to pay the full amount of the purchase price due to capital constraints and need financing support.

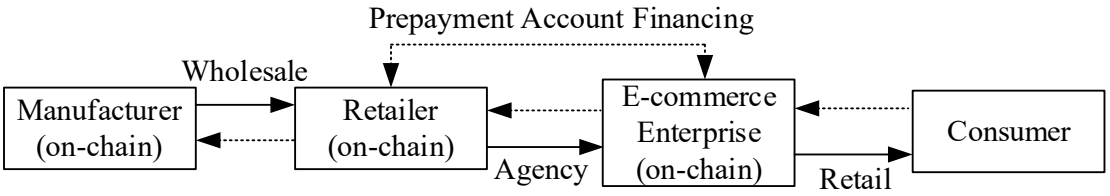
According to the blockchain platform construction entity (manufacturer or e-commerce enterprise) and the choice of financing channels, four financing models can be identified: traditional downstream e-commerce enterprise financing, mixed financing involving traditional banks, e-commerce enterprise financing based on e-commerce blockchain platform, and bank financing based on manufacturer blockchain platform, as shown in Figure 3.



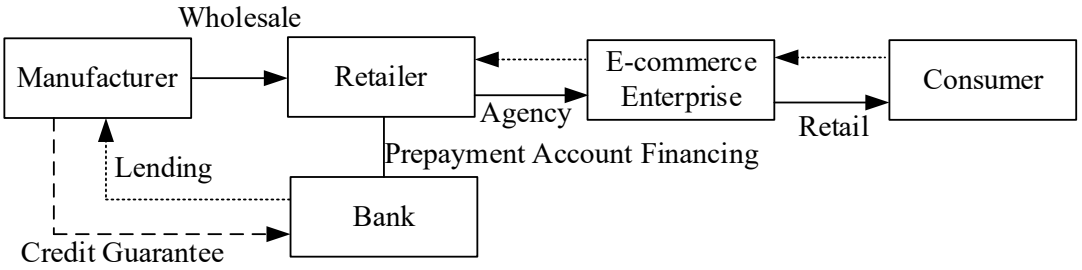
(1) Traditional Downstream E-commerce Enterprise Financing



(2) Traditional Bank-Involved Hybrid Financing



(3) E-commerce Blockchain Platform-Based E-commerce Financing



(4) Manufacturer Blockchain Platform-Based Bank Financing

Figure 3: Comparison of financing models of downstream e-commerce companies

In the traditional downstream e-commerce enterprise financing model, manufacturers and counterfeiters supply goods to retailers with capital constraints through wholesale channels, and the goods are then transferred to e-commerce companies through retailers and eventually flow to consumers. In this model, e-commerce companies directly provide retailers with prepaid account financing, but they have to bear the risk of counterfeiters forging transactions, information verification relies on manual review, and the capital flow path is lengthy, and efficiency is limited.

The hybrid financing model involving traditional banks introduces banks as external funding parties, and manufacturers need to provide credit guarantees to retailers in exchange for genuine prepaid account financing support from banks. The capital chain involves the collaboration of banks, e-commerce companies, retailers, and manufacturers. The complex hierarchical approval leads to delayed credit, and counterfeiters can still use information blind spots to arbitrage. Manufacturers face additional guarantee risks and supply chain coordination pressure.

In the financing model based on the e-commerce blockchain platform, the transaction data between manufacturers and retailers is uploaded to the chain in real time, and the smart contract automatically verifies the authenticity of the order and triggers the e-commerce prepaid account financing. The data in the blockchain environment cannot be tampered with, eliminating interference from counterfeiters (Jiang & Chen, 2021), and the capital path is simplified to "blockchain contract → retailer → consumer". The e-commerce platform obtains data service value by operating the chain ecosystem, while reducing manual review costs and operational risks.

The bank financing model based on the manufacturer's blockchain platform is led by the manufacturer in the blockchain infrastructure, and its credit is extended to retailers through the historical order data on the chain. Banks directly lend based on verifiable purchase records without the need for traditional credit guarantee agreements, and end retailers receive

financing support that matches their actual contributions. Manufacturers strengthen brand credibility through product traceability functions, improve consumer demand response speed, and systematically reduce multi-level financing costs in the supply chain.

The common value of blockchain empowerment is reflected in process penetration and ecological scalability. Technology breaks down traditional hierarchical barriers, and the flow of funds shifts from multi-level approval to end-to-end direct access; on-chain data replaces manual verification and guarantee, and small and medium-sized retailers obtain financing based on transaction records (Kong, 2023); smart contracts automatically intercept abnormal transactions, and local risks cannot spread to the entire chain; leading enterprises (e-commerce or manufacturers) upgrade from a single transaction role to an ecological governance role through the right to formulate on-chain rules, achieving a dual leap in financing efficiency and market value.

Integrated Theoretical Framework for Blockchain-Enabled Supply Chain Financing
As shown in Table 3, basked on the analysis of three types of financing relationships, this study constructs an integrated theoretical framework for blockchain-enabled supply chain financing, revealing four core mechanisms:

Table 3
Four core mechanisms of blockchain-enabled supply chain financing

Core Mechanism	Key Manifestations	Theoretical Significance
Information Sharing Mechanism	Distributed ledger records transaction information, ensuring data immutability; Real-time multi-party data sharing eliminates information silos; Smart contracts automate transaction execution.	Fundamentally transforms supply chain information structure, reducing information asymmetry.
Credit Transmission Mechanism	Cross-tier transmission of core enterprise credit, breaking hierarchical limitations; Credit evaluation shifts from linear relationships to holistic transaction networks.	Reconstructs supply chain credit systems, resolving traditional credit transmission barriers.
Cost Optimization Mechanism	Reduces credit investigation costs and simplifies due diligence; Minimizes transactional friction; Lowers risk premiums caused by information asymmetry.	Optimizes financing cost structures, alleviating the "high financing costs" challenge.
Value-Added Mechanism	Anti-counterfeit traceability creates additional market value; Product quality improvements enhance brand equity; Consumer trust builds long-term competitive advantages.	Expands blockchain's functional boundaries, delivering value beyond financing efficiency.

These four mechanisms are interrelated and mutually reinforcing, and together constitute the theoretical basis for blockchain to empower supply chain financing. Blockchain technology effectively solves the core problems of information asymmetry, limited credit transmission, and difficult risk control in traditional SCF by reconstructing the supply chain information structure, credit mechanism, and value creation path, laying a theoretical foundation for the integrated development of "blockchain + SCF".

At the same time, this study found that blockchain platforms dominated by different entities (manufacturers, banks, e-commerce companies) have different governance mechanisms and value distribution, which affect the evolution path of the financing ecosystem and the strategic choices of participants. This difference is reflected in the platform entry thresholds, value distribution rules, service priorities, and data ownership, providing differentiated blockchain adoption strategy guidance for various companies. This finding forms a complete theoretical loop with the previous theoretical analysis on the importance of blockchain platform governance.

Discuss

This study is based on the multi-level supply chain scenario (upstream manufacturers, midstream distributors, and downstream e-commerce companies) and systematically reveals the logic of blockchain technology in reconstructing financing decisions. From a management perspective, blockchain is not a simple efficiency tool, but rather promotes a deep transformation of supply chain governance models and value creation logic by changing information control rights and credit allocation rules.

In the traditional financing system, core enterprises (such as manufacturers) dominate financing rules through information monopoly and credit intermediary status, forming a centralized power structure. The intervention of blockchain technology transforms supply chain transaction data into verifiable public credentials on the chain, weakening the exclusivity of a single subject to information. This shift forces companies to reposition their roles: core companies need to shift from 'credit monopolists' to 'ecological coordinators', and small and medium-sized enterprises can improve their financing bargaining power through on-chain data accumulation. This transformation aligns with Zhou et al. (2025a)'s integration of the TOE framework and Dynamic Capabilities theory, which emphasizes that technological innovation (the 'technology' dimension) must be coupled with organizational capabilities (e.g., sensing market risks, reconfiguring governance rules) to achieve adaptive financing strategies. Blockchain's disruption of information monopolies exemplifies how enterprises can operationalize dynamic capabilities, such as balancing decentralized data control with centralized coordination, to navigate power redistribution in MTSC.

This dynamic mirrors the findings of Zhou et al. (2025b) on risk-averse SMEs in low-carbon supply chains, where hybrid financing strategies (e.g., mixed financing) enabled firms to balance financial stability with sustainability goals by dynamically reconfiguring funding sources. Similarly, blockchain's traceability allows SMEs to signal credibility through verifiable transaction records, reducing reliance on traditional credit intermediaries—a process akin to 'seizing hybrid financing opportunities' in green transition scenarios. However, it is worth noting that the essence of technology empowerment is the redistribution of power, and companies need to be wary of the illusion of 'technological neutrality'—the competition for dominance of blockchain platforms may trigger new governance conflicts.

Another management value of blockchain is to build a synergistic mechanism of "technical trust" and "institutional trust". Traditional supply chains rely on contractual constraints and relationship investment to build trust, while blockchain reduces the cost of building trust through tamper-proof data records and automatic execution of smart contracts. However, the limitation of technical trust is that it can only verify "facts that have occurred" and cannot

replace the strategic relational trust embedded in long-term cooperative dynamics, such as Guanxi—the cultural mechanism of mutual obligation that mediates supply chain cooperation and performance (Wang et al., 2025). Managers need to balance technical empowerment and relationship capital investment to avoid over-reliance on on-chain data and neglect of supply chain flexibility. This balance mirrors insights from organizational studies, where flexible work arrangements improved performance only when aligned with employees' operational habits (Mahmood et al., 2019).

Conclusion

This study demonstrates blockchain's capacity to mitigate information asymmetry and credit fragmentation through three restructured mechanisms: distributed ledger-enabled information transparency, cross-tier credit penetration, and smart contract-driven value allocation. The technology empowers SMEs to leverage data association while enabling end-user enterprises to obtain contribution-matched financing.

However, the realization of technology empowerment is subject to practical constraints. The competition for blockchain platform governance rights may lead to new power imbalances. For example, data control rights may be transferred from traditional core enterprises to technology platform leaders, forming new monopoly risks. In addition, technical trust cannot completely replace the strategic mutual trust between supply chain members, and the authenticity verification of on-chain data still needs to be combined with traditional relationship governance. Future research needs to deepen the exploration of technical governance rules (such as data usage rights allocation standards) and on-chain and off-chain trust coordination mechanisms to provide theoretical support for the robust application of blockchain in SCF.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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