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# Theoretical Evolution and Research Review of Supply Chain Finance in the Context of the Digital Economy

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**Abstract:** Against the backdrop of deep integration between the digital economy and the real economy, supply chain finance is accelerating its transformation from traditional offline models to digitalized, platform-based, and intelligent ones. Digital technologies have not only reshaped the business processes and risk management approaches of supply chain finance, but also propelled its theoretical foundations to extend from traditional financial intermediation theory and information asymmetry theory toward data factor theory, platform ecosystem theory, and network governance theory. Taking theoretical evolution as the main thread, this paper systematically reviews the internal logic and research trajectory of digital economy-enabled supply chain finance, offering a critical assessment from four dimensions: the theoretical limitations of traditional supply chain finance, theoretical breakthroughs driven by digital transformation, research progress and controversies, and future development directions. The study finds that digital supply chain finance has formed new theoretical explanations for alleviating financing constraints for SMEs, reducing transaction costs, and optimizing credit pricing, yet theoretical gaps remain regarding data property rights, platform governance, and systemic risks. Future research should further strengthen theoretical integration, focusing on digital factor pricing, cross-entity governance mechanisms, and risk transmission patterns, so as to provide theoretical support for the high-quality development of supply chain finance.

**Keywords:** Digital economy; Supply chain finance; Theoretical evolution; SME financing

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## 1. Introduction

As an important financial arrangement for alleviating financing constraints on small and medium-sized enterprises (SMEs) and enhancing the operational efficiency of industrial chains, supply chain finance has long attracted sustained attention in the fields of economics and corporate finance. Traditional supply chain finance relies on core enterprise credit, real transaction backgrounds, and offline risk control measures, which to some extent mitigate information asymmetry and the lack of collateral, but still suffer from limitations such

as cumbersome processes, limited coverage, and lagging risk identification. With the widespread application of digital technologies such as big data, blockchain, artificial intelligence, and the Internet of Things, the digital economy is profoundly transforming the operational logic of supply chain finance from the technical level to the institutional and theoretical levels. At present, platform-led, data-driven, and ecosystem-collaborative supply chain finance models are constantly emerging, while traditional financial intermediation theory, transaction cost theory, and information asymmetry theory can no longer fully explain the credit generation, risk pricing, and value distribution mechanisms of digital supply chain finance. Therefore, systematically reviewing the theoretical evolution of supply chain finance in the context of the digital economy and summarizing existing research achievements and deficiencies is of great significance for promoting theoretical innovation and policy optimization.

## 2. Theoretical foundations and practical limitations of traditional supply chain finance

### 2.1. Core theoretical support of traditional supply chain finance

The theoretical system of traditional supply chain finance is built upon classical corporate finance and new institutional economics, with four core theoretical pillars. First, information asymmetry and credit rationing theory. Due to severe information asymmetry between financial institutions and SMEs, banks are prone to credit rationing behavior, which leads to SMEs facing difficulties in accessing affordable financing. Supply chain finance, by introducing core enterprise credit and real transaction information, can effectively reduce information asymmetry and broaden enterprise financing availability. Stiglitz and Weiss [1] proposed the credit rationing theory, providing core theoretical support for this issue. Hu and Huang [2] also clarified that information asymmetry is the core motivation for the emergence of supply chain finance by reviewing its concepts and connotations, and its core value lies in mitigating adverse selection and moral hazard in the credit market through integrating industrial chain information. Second, transaction cost theory. Traditional credit models involve high investigation, contracting, and monitoring costs. Supply chain finance, by integrating logistics, capital flows, and information flows, achieves economies of scale and process simplification, thereby reducing the costs of the entire financial transaction process. Coase [3] laid the foundation for transaction cost theory, and Williamson [4] further expanded this theoretical framework. Xia *et al.* [5], in reviewing the theoretical evolution of supply chain finance, found that the reduction of transaction costs is both the core logic of traditional supply chain finance model innovation and the key mechanism for enhancing industrial chain efficiency. Third, signaling and reputation mechanism theory. The performance capability and credit level of core enterprises can provide implicit guarantees for SMEs in the chain, and stable transaction relationships serve as signal display carriers of enterprise credit, helping SMEs gain the trust of financial institutions. Spence [6] proposed signaling theory, providing a theoretical basis for this mechanism. Xiong *et al.* [7] showed that core enterprise credit endorsement and SME transaction reputation can significantly improve SME financing availability, confirming the application value of this theory in supply chain finance. Fourth, principal-agent and contract theory. Supply chain finance, through structured contract design, clarifies the rights and obligations of core enterprises, SMEs, financial institutions, and logistics enterprises, reducing moral hazard and adverse selection behavior and improving contract execution efficiency. Jensen and Meckling [8] revealed the conflicts of interest under information asymmetry. Yan and Sun [9], by constructing a supply chain finance contract model, found that reasonable contract design can coordinate the interests of all parties in the supply chain, reduce

moral hazard, and improve financing efficiency, further enriching the application of contract theory in the field of supply chain finance.

### 2.2. Theoretical and practical limitations of traditional supply chain finance

Before the advent of the digital economy, traditional supply chain finance had many prominent shortcomings. These shortcomings not only constrained the exertion of its service effectiveness but also provided theoretical and practical space for the rise of digital supply chain finance. First, credit transmission has obvious limitations. The credit of core enterprises can only cover their first-tier upstream and downstream partners, making it difficult to reach long-tail SMEs in the industrial chain. Song and Chen [10] pointed out that the credit transmission of traditional supply chain finance highly depends on offline transaction verification, and hierarchical barriers are difficult to break through, resulting in a large number of micro, small, and medium-sized enterprises being unable to enjoy the benefits of supply chain finance services. Second, information integration and risk control capabilities are insufficient. Information within the supply chain is fragmented and non-standardized, and excessive reliance on manual verification and offline risk control models makes it difficult to achieve dynamic risk monitoring. Traditional supply chain finance has not fundamentally solved the problem of information asymmetry. The low efficiency of offline verification not only limits risk control effectiveness but also easily triggers risks such as fraudulent trade [11]. Third, theoretical explanatory power is gradually weakening. Traditional theories center on asset collateral, entity credit, and bilateral contracts, and can no longer adapt to new financial models that are collateral-free, data-driven, and platform-ecosystem-based. With the iterative development of supply chain finance, the adaptability of traditional theoretical frameworks continues to decline, and new theoretical perspectives are urgently needed to improve the explanatory system [5]. Fourth, risk management shows lag. Traditional models mostly rely on ex-post tracing rather than ex-ante early warning. The limitations of offline verification lead to untimely risk identification, making it prone to problems such as fraudulent trade and repeated pledging. This lagging risk control model cannot keep up with the pace of business development, further constraining the inclusiveness of traditional supply chain finance services [12].

## 3. Theoretical breakthroughs and evolution of supply chain finance driven by the digital economy

The digital economy, with data as the key production factor, technology platforms as important carriers, and network collaboration as the operating mode, drives supply chain finance to achieve transformation from offline, single-chain, entity credit to online, ecosystem-based, data credit, giving rise to new theoretical explanatory frameworks.

### 3.1. Upgrading of information mechanism theory

Big data and artificial intelligence technologies enable real-time collection and deep mining of multi-dimensional information such as enterprise operations, transactions, logistics, and taxation, allowing financial institutions to shift from static information to dynamic profiling and from local information to global views. Traditional theory centers on alleviating information asymmetry, while digital supply chain finance further achieves information penetration and information credibility. The introduction of data factors means that credit assessment no longer relies on financial statements and collateral assets, but is based on behavioral data, transaction data, and operational data, forming a more comprehensive risk judgment mechanism. Wu and Tian

[13] pointed out that the tamper-proof characteristics of blockchain technology can achieve credible transmission of supply chain information, solve the problem of information forgery in traditional supply chain finance, and promote the transformation of information mechanisms from passive verification to active penetration.

## 3.2. Reconstruction of credit generation theory

Traditional supply chain finance highly depends on core enterprise entity credit and collateral. Digital supply chain finance, however, drives a fundamental change in the credit generation mechanism. Based on the tamper-proof characteristics of blockchain and the real-time tracking capabilities of the Internet of Things, real transactions can be automatically authenticated, recorded, and executed, forming a new credit system that integrates transaction credit, data credit, and ecosystem credit. Credit no longer solely depends on enterprise entity qualifications, but on real transactions and data closed loops guaranteed by digital technology, which is an important extension of traditional credit theory. Research found that data credit has become one of the core hotspots in digital supply chain finance research.

## 3.3. Transformation of organizational model theory

In the digital economy, the participants of supply chain finance are no longer limited to banks, core enterprises, and SMEs, but have expanded to technology companies, e-commerce platforms, logistics platforms, industrial internet platforms, and other parties, forming a platform-based ecosystem. As data hubs and governance entities, platforms undertake functions such as information integration, risk pricing, rule-making, and multi-party coordination, weakening the single dominant position of traditional financial intermediaries. This transformation aligns with platform economy theory, network organization theory, and ecosystem theory, providing new perspectives for understanding the organizational structure evolution of supply chain finance. Xue and Liu [14] pointed out that in the context of the digital economy, supply chain finance has shifted from single-chain financial services to ecosystem-based financial collaboration. The platform-based organizational model can achieve efficient resource integration and enhance the overall financing efficiency and resilience of the supply chain. Moreover, innovation in the supply chain finance ecosystem can promote the security and stability of industrial chains and supply chains, and the platform, as the core of the ecosystem, has its governance capacity directly determining the operational efficiency and risk level of the ecosystem [15].

## 3.4. Innovation in contract and governance theory

Smart contracts, blockchain attestation, and automated execution mechanisms are driving supply chain finance to evolve from traditional incomplete contracts to intelligent and automated contracts. Smart contracts can automatically complete operations such as disbursement, repayment, pledging, and de-pledging when preset conditions are met, reducing human intervention and opportunistic behavior. At the same time, digital supply chain finance emphasizes cross-entity, cross-chain, and cross-data collaborative governance, forming a governance structure with the participation of government, platforms, financial institutions, and enterprises, enriching the theoretical connotations of corporate governance and industrial governance. Fan *et al.* [16] pointed out that smart contracts empowered by blockchain technology can effectively solve the problems of high contract execution costs and high default risks in traditional contracts, promoting innovation in contract theory toward intelligence and automation. The application of blockchain in supply chain finance not only optimizes contract execution mechanisms but also promotes innovation in cross-entity governance models [17], forming a multi-party collaborative risk-sharing and benefit-sharing mechanism.

## 4. Research progress and main consensus of digital supply chain finance

Existing literature has conducted extensive research on digital supply chain finance, forming a relatively clear research trajectory and basic consensus. Digital technology can significantly alleviate financing constraints on SMEs. Big data risk control, data credit, and platform empowerment have lowered entry barriers and improved financing availability and efficiency. Zhu [17] pointed out that digital supply chain finance, through technological empowerment, breaks the service boundaries of traditional supply chain finance and can effectively cover long-tail SMEs and alleviate their financing constraints. The integration of digital inclusive finance and supply chain finance can further enhance SME financing availability and help build a new dual-circulation development pattern [18]. Digital supply chain finance can also reduce transaction costs and risk levels. Through process digitalization, intelligent risk control, and information transparency, it effectively reduces ex-ante screening, in-process monitoring, and ex-post default risks, improving the operational efficiency of the entire supply chain. Gao [19] found that the digital transformation of supply chain finance can significantly reduce the operational and risk control costs of financial institutions while reducing enterprise financing costs, achieving a win-win situation for both parties. Digital transformation can optimize business processes, enhance risk identification and control capabilities, and reduce the probability of risks such as fraudulent trade and repeated pledging [20]. Data factors have become an important basis for credit pricing. Multi-dimensional data can replace some functions of traditional collateral, promoting risk pricing to shift from relying on entity qualifications to relying on transaction behavior, enhancing pricing accuracy and inclusiveness. Liu *et al.* [21] showed that the integration and application of data factors can significantly improve the accuracy of supply chain finance risk pricing and reduce risks caused by pricing deviations. Platform ecosystemization helps enhance the overall resilience of the supply chain. Digital supply chain finance breaks the limitations of a single chain, achieves cross-chain, cross-regional, and cross-industry resource integration, and strengthens the anti-risk capability of the industrial chain. Zhu and Zhang [22] pointed out that the "dual-chain linkage" model of digital supply chain finance can enhance supply chain flexibility and anti-risk capability, helping rural revitalization and industrial chain stability. At present, supply chain resilience has become an important direction of digital supply chain finance research, and platform ecosystemization is one of the core paths to enhance supply chain resilience. Meanwhile, research also shows certain differences. For example, questions such as whether excessive platform concentration brings monopoly and data hegemony, whether digital technology, while improving efficiency, also generates new technological and compliance risks, and how unclear data property rights affect long-term incentives still require further theoretical deepening.

## 5. Deficiencies in existing research and theoretical gaps

Although research on digital supply chain finance has achieved rich results, from the perspective of theoretical evolution, there are still obvious gaps. First, the degree of theoretical integration is insufficient. Most studies remain at the level of simple application of technology and traditional theories, lacking a general theoretical framework that can uniformly explain data credit, platform governance, and ecosystem collaboration. Although existing digital supply chain finance research exhibits interdisciplinary characteristics, theoretical integration is insufficient, and a systematic theoretical system has not yet been formed, making it difficult to fully explain the internal logic of digital technology-enabled supply chain finance. Moreover, the fragmentation of supply chain finance theory is prominent, especially in the context of the digital economy, where research from different theoretical perspectives lacks effective integration, constraining the improvement of theoretical explanatory

power [5]. Second, theoretical research on data factors is weak. Existing research has insufficient discussion on issues such as data rights confirmation, data pricing, and data revenue distribution, making it difficult to support the long-term institutional design of digital supply chain finance. Third, research on platform governance and risk mechanisms is not in-depth. Existing research mostly emphasizes the positive effects of digital supply chain finance, with insufficient attention to issues such as platform monopoly, regulatory arbitrage, systemic risk, and algorithmic discrimination. Li [17] found that digital supply chain finance faces such new types of risks during rapid development, but existing research has not explored the formation mechanisms and governance paths of these risks in sufficient depth, making it difficult to support the practical needs of risk prevention and control. Fourth, micro-mechanism and heterogeneity analysis need to be strengthened. The differences in benefits and mechanisms of action for enterprises of different industries, sizes, and ownership types in digital supply chain finance still require more rigorous theoretical and empirical support. Liu *et al.* [21] showed that the synergistic effect of digital transformation technology and supply chain finance exhibits enterprise heterogeneity, but existing research has insufficient theoretical explanation of this heterogeneity, making it difficult to reveal the differences in the mechanisms of digital supply chain finance under different scenarios.

## 6. Research prospects and future directions

Facing the requirements of high-quality development of the digital economy and the real economy, future theoretical research on supply chain finance can focus on five major directions. First, construct a general theoretical framework for digital supply chain finance, integrating data factor theory, platform economy theory, credit theory, and governance theory to form a systematic theoretical system. Second, strengthen research on platform ecosystems and multi-party governance, analyzing platform rights and responsibility boundaries, regulatory rules, cross-entity collaboration, and risk-sharing mechanisms. Li [17] suggested that future research should focus on the core issues of platform governance, clarify the rights and responsibility boundaries of platforms, and establish sound cross-entity collaborative governance mechanisms and risk-sharing mechanisms to prevent platform monopoly and systemic risks. Third, pay attention to the integration of digital supply chain finance with green finance, industrial chain security, and common prosperity goals, expanding theoretical application scenarios. Wang [15] pointed out that the integration of digital supply chain finance and green finance can promote the green transformation of industrial chains and enhance industrial chain security levels, but existing research has insufficient discussion of the theoretical mechanisms of this integration, and future research should strengthen relevant theoretical studies. Finally, strengthen research on institutional characteristics in the context of Chinese-style modernization, combining China's industrial policies, financial structure, and digital economy development characteristics to form local theories with greater explanatory power and guidance. Zhu [18] pointed out that the development of digital supply chain finance in China has distinct institutional characteristics. Future research should combine China's practice to construct a digital supply chain finance theoretical system with Chinese characteristics, providing theoretical support for the high-quality development of supply chain finance in China.

## 7. Conclusion

Driven by the digital economy, the digital transformation of supply chain finance has not only reshaped business models and risk management logic, but also propelled its theoretical system to achieve systematic

iteration, completing the extension and expansion from traditional core theories to new theories such as data factors and platform ecosystems. The practical value of digital supply chain finance in alleviating SME financing constraints, optimizing credit pricing mechanisms, and enhancing industrial chain resilience has been fully verified. However, problems such as insufficient theoretical integration, weak research on data factors, and lack of platform governance and micro-heterogeneity analysis still constitute the core shortcomings of current theoretical development. Future research needs to be grounded in localized practice, focusing on key dimensions such as theoretical system reconstruction, data credit mechanism improvement, and platform collaborative governance optimization, filling theoretical gaps, strengthening the guiding effectiveness of theory on practice, and providing solid theoretical support for the high-quality development of supply chain finance and the security and stability of industrial chains and supply chains.

## Disclosure statement

The author declares no conflict of interest.

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