

A Study on the Collaborative Mechanism of County-Level Digital Supply Chain Finance in Empowering Rural Revitalization

Yujie Jiao

Shandong Institute of Commerce and Technology, China

Abstract: Against the backdrop of the in-depth implementation of the rural revitalization strategy, financial supply at the county level faces significant structural challenges, notably manifested in difficulties in financing for small, medium, and micro enterprises, insufficient coverage of rural financial services, and the poor fit between traditional financial models and the characteristics of the county-level economy. Digital supply chain finance serves as an innovative pathway to resolve these challenges. By establishing an effective coordination mechanism at the county level that integrates the “flow of information, flow of capital, and flow of credit,” it creates a dynamic balance where information generates credit, credit directs capital, and capital feeds back into information—together forming the core operational logic of the county-level digital supply chain finance ecosystem.

Keywords: Supply chain finance; Digital finance; Rural revitalization; County-level economy; Collaborative research.

1. Introduction

Against the backdrop of the comprehensive advancement of the rural revitalization strategy, the high-quality development of the county-level economy—as a key hub connecting urban and rural areas and bridging higher-level and local levels—holds significant strategic importance. However, the development of county-level finance has long faced profound structural contradictions. On the one hand, economic entities in these counties are predominantly small, medium, and micro enterprises, new types of agricultural business entities, and dispersed farming households. These entities generally suffer from inadequate financial systems and a lack of viable collateral, causing traditional financial institutions to face severe information asymmetry and credit assessment challenges; On the other hand, the county-level financial system suffers from a pronounced outflow of capital, with funds continuously shifting toward central cities or non-agricultural sectors, imposing severe financing constraints on the transformation and upgrading of local industries. These multiple mismatches on both the supply and demand sides indicate that traditional financial models struggle to effectively adapt to the complex economic ecosystem of county-level regions.

To address this challenge, digital supply chain finance has emerged as an innovative financial service model. Leveraging digital technologies such as the Internet of Things (IoT), big data, and blockchain, it embeds financial services into real-world transaction scenarios within industrial chains, using digital means to empower the entire supply chain—from upstream to downstream. However, current practices in digital supply chain finance are largely concentrated in mature industrial chains dominated by urban areas or large core enterprises. At the county level—a specific spatial scale—the implementation of digital supply chain finance still faces numerous challenges due to a weak industrial foundation, severe data silos, and an incomplete credit system. How to establish an effective coordination mechanism at the county level—one that enables the smooth flow and mutual

empowerment of capital, information, and credit—has become an urgent theoretical and practical issue. This paper focuses on the coordination mechanisms of county-level digital supply chain finance, conducting a theoretical analysis from the three dimensions of information, credit, and capital to explore its construction pathways, closed-loop logic, and operational prerequisites, with the aim of providing a theoretical reference for county-level financial supply-side reform and rural revitalization.

2. Research Progress on Digital Supply Chain Finance Empowering Rural Revitalization

As a product of the deep integration of fintech and supply chain finance, digital supply chain finance has become a key engine for resolving financing challenges in agriculture, rural areas, and farmers, and for driving the industrial upgrading of rural areas. Existing literature on digital supply chain finance primarily focuses on the following dimensions.

First, regarding the definition and core value of digital supply chain finance, a basic consensus has been reached within the academic community. A systematic review by Wang Huan et al. (2026) points out that the essence of digital supply chain finance lies in leveraging cutting-edge technologies such as big data, blockchain, and the Internet of Things (IoT) to reshape supply chain operations. Its core value lies in achieving “improved efficiency, increased trust, and reduced risk” through technological empowerment, thereby effectively resolving the financing challenges that have long plagued small, medium, and micro-sized entities involved in agriculture [1]. This positioning clarifies its role as a technological financial tool that bridges the digital economy and the real economy and empowers rural revitalization.

Second, research has confirmed the concrete application effects of digital supply chain finance in rural revitalization contexts. Li Ji (2026), based on a bibliometric analysis, found that research in this field is strongly policy-driven, with the

forefront focusing on themes such as inclusive finance, digitization, and financing—which correspond to the core roles of enhancing the accessibility of financial services, optimizing service efficiency, and alleviating funding bottlenecks [2]. However, there remains a gap between ideal expectations and reality. Li Mengzhen (2022) conducted an in-depth analysis of the unique characteristics of rural contexts, pointing out that the development of rural supply chain finance faces four major bottlenecks: a weak rural economic foundation, insufficient supply of financial services, information silos caused by the absence of a credit reporting system, and lagging digital infrastructure [3]. This indicates that the introduction of technology must be integrated with the complex socioeconomic realities of rural areas.

Subsequently, research began to delve deeper into the specific pathways through which it empowers rural revitalization. The empirical study by Shen Yun et al. (2026) achieved a significant breakthrough. Using modern agricultural industrial parks as a case study, they found that digital supply chain finance in agriculture effectively promotes the integration of smallholder farmers into the modern agricultural system primarily through three transmission pathways: increasing the coverage of commercialized agricultural services, driving the transformation of agricultural production technologies, and optimizing the industrial structure of the parks. This finding concretizes the abstract concept of empowerment into a chain of observable and verifiable mechanisms, providing a key analytical framework for subsequent research. More notably, the study emphasizes that the effective functioning of these mechanisms is not automatic but highly dependent on the coordinated governance of a “proactive government” and an “effective market” [4]. From a technical implementation perspective, the necessity of such coordination is equally evident. The literature by Wang Chengfu et al. (2025) systematically analyzes the coordination barriers in technology implementation. Whether in models led by core enterprises or financial institutions, challenges are commonly encountered, including insufficient willingness to share data, difficulties in ensuring the authenticity of on-chain data, high costs of system deployment and operation and maintenance, and the complexity of coordinating on-chain and off-chain business operations. Overcoming these obstacles cannot rely on a single entity; there is an urgent need for collaboration among multiple parties—including the government, technology platforms, and supply chain enterprises—to jointly establish mechanisms for sharing data value, sharing costs, and balancing benefits [5]. This underscores the urgency of establishing collaborative mechanisms from a technical implementation perspective.

Finally, macro-level research on regional disparities provides direct justification for focusing on the county level. Wang Zhilin et al. (2025) measured the development level of China’s agricultural digital supply chain finance and found that its development exhibits significant regional imbalances, with intra-regional differences being the primary source of overall disparities [6]. This finding suggests that at the county level—as a key spatial unit for policy implementation, resource allocation, and industrial deployment—developmental imbalances and complexities are even more pronounced.

Therefore, researching how to integrate diverse stakeholders—including local governments, financial institutions, core enterprises, farmer cooperatives, and

technology service providers—within a single county to establish effective collaborative mechanisms is of critical importance for narrowing local disparities and tangibly enhancing the overall effectiveness of financial empowerment in rural revitalization.

In summary, existing literature has clearly outlined the value, pathways, and challenges of digital supply chain finance in empowering rural revitalization, and there is widespread recognition that cross-stakeholder collaboration is key to overcoming bottlenecks and unlocking its full potential. However, existing research either focuses on macro-level models and policy analysis or delves into micro-level case studies of farmers and industrial parks; there remains a lack of systematic theoretical research on collaboration mechanisms among diverse stakeholders from the perspective of the county-level system as a whole. This study aims to investigate how, within a county-level context, an institutionalized collaboration framework can be designed to integrate the resources and actions of all parties, thereby effectively driving digital supply chain finance to comprehensively and deeply empower rural revitalization.

3. Theoretical Implications of Collaborative Mechanism

In the county-level digital supply chain finance ecosystem, the collaboration mechanism achieves organic interconnection among various elements within the system and maximizes value through specific rules and technical means. To understand this mechanism, a theoretical analysis must be conducted from three dimensions: the objects of collaboration, its objectives, and its essence.

3.1. The Subjects of Collaboration

Information, credit, and capital are the core elements of digital supply chain finance operations and constitute the underlying logic of the financial ecosystem. Under traditional county-level financial models, these three elements often exhibit severe disconnects. First is the information disconnect: government data (such as land title registration, taxation, and subsidies), industrial data (such as agricultural input procurement and agricultural product sales), and financial data within counties are scattered across different departments and institutions, creating information silos that prevent financial institutions from obtaining a comprehensive profile of borrowers. Second is the credit disconnect. Due to the lack of continuous, reliable transaction data, small and micro enterprises in rural counties struggle to convert their business activities into credit assets recognized by financial institutions. Credit assessments rely heavily on traditional collateral and guarantees, hindering the credit transmission mechanism. Finally, there is a funding gap. The lack of information and credit directly leads to either blind or overly conservative lending practices. Funds struggle to be precisely channeled to the weak links in industrial chains, and the flow of funds is difficult to monitor, making them highly susceptible to misappropriation and resulting in misallocation of funds.

3.2. The Objectives of Collaboration

The fundamental objective of establishing a collaborative mechanism is to bridge these gaps and achieve comprehensive connectivity of the “three flows” and a closed-loop ecosystem. Information connectivity aims to

eliminate data silos; through standardization and platform-based approaches, it facilitates the aggregation and sharing of multi-source, heterogeneous data, providing a solid data foundation for credit assessment. Credit integration requires establishing a credit evaluation system based on actual transaction contexts and dynamic operational data—beyond traditional asset collateral—so that credit can be smoothly transmitted and mutually recognized across the upstream and downstream segments of the industrial chain. Capital integration emphasizes the precision of capital allocation and the closed-loop nature of recovery, ensuring that funds are allocated strictly according to the actual needs of the industrial chain and recovered in a closed-loop manner upon transaction completion, thereby fundamentally controlling financial risks.

3.3. The Essence of Collaboration

The county-level digital supply chain finance ecosystem involves diverse stakeholders, including local governments, commercial banks, core enterprises, guarantee institutions, technology companies, and a vast number of farmers. However, the essence of the collaborative mechanism lies in the dynamic matching relationships among the “three flows” during interactions that span multiple entities and processes. Specifically, this refers to aligning the generation frequency of the information flow with the assessment cycle of the credit flow; matching the credit limit of the credit flow with the scale of capital disbursement; and aligning the direction of the capital flow with the monitoring nodes of the information flow. This dynamic alignment requires breaking down traditional departmental barriers and operational boundaries. Through institutional design and technological empowerment, the information flow, credit flow, and capital flow are integrated into a closed-loop collaboration across time, space, and logic, thereby reshaping the trust foundation and service models of county-level finance.

4. Building a Collaborative Mechanism of “Information Flow, Credit Flow, and Capital Flow”

Based on the above theoretical analysis, digital supply chain finance in county-level areas that empowers rural revitalization should establish a coordination mechanism centered on the integration of “information flow, credit flow, and capital flow.” Through the coordination of information flow, data sharing and mutual recognition are achieved; through the coordination of credit flow, dynamic credit assessment is realized; and through the coordination of capital flow, closed-loop and controllable circulation is ensured. These three elements are interdependent and dynamically aligned, forming a closed-loop logic where “information generates credit, credit guides capital, and capital feeds back into information.” Establishing this coordination mechanism requires not only technical support but also institutional safeguards and organizational coordination. This will enable the precise alignment of financial resources with rural industrial development at the county level, ultimately achieving the goal of empowering rural revitalization.

4.1. Collaboration of Information Flow

Information flow coordination serves as the starting point and cornerstone of the entire mechanism. The complexity of county-level information requires the establishment of a

comprehensive coordination system covering the entire process—from data collection and integration to application. Regarding data sources, multidimensional cross-verification must be implemented, including breaking down administrative barriers to incorporate government data from agencies such as industry and commerce, taxation, justice, and agriculture and rural affairs, as well as leveraging core enterprises or industrial platforms to obtain authentic transaction data on orders, logistics, and settlements. At the same time, IoT devices such as smart sensors and drone inspections should be widely deployed to collect real-time physical data on underlying assets, such as crop growth and warehouse conditions. The integration of data from multiple sources can effectively mitigate the risk of data falsification associated with relying on a single data source.

Regarding data standards and platform-based integration, county-level governments should take the lead in building a unified public service platform for digital supply chain finance. This platform must establish uniform data interface standards and data dictionaries to convert unstructured agricultural and industrial data into structured data that financial institutions can read. Through platform-based operations, it will achieve data interoperability among government, banks, and enterprises, thereby completely breaking down information silos.

At the same time, information flow coordination must address issues of data privacy protection and value distribution. During data sharing, privacy-preserving computing technologies—such as federated learning and multi-party secure computation—should be introduced to ensure that “data is usable but not visible,” thereby alleviating concerns among all parties regarding the leakage of trade secrets and personal privacy. Establishing a reasonable mechanism for distributing the benefits derived from data elements will incentivize core enterprises and technology companies to actively contribute high-quality data, fostering a sustainable information-sharing ecosystem and thereby transforming data from a state of disorderly dispersion to one of shared recognition.

4.2. Collaboration of Credit Flow

Credit flow collaboration aims to transform vast amounts of information into quantifiable credit assets, thereby reshaping the credit system for entities at the county level. To achieve this goal, a dynamic credit assessment mechanism based on transactions must first be established. Traditional finance relies on financial statement data and fixed-asset collateral, whereas digital supply chain finance shifts its focus to borrowers’ historical transaction records, performance capabilities, and future cash flows. Through big data risk control models, the operational status of borrowers is analyzed in real time, with high-frequency, dynamic monitoring and assessment. Upon detecting abnormal fluctuations, the system can automatically trigger alerts and adjust credit limits, enabling early risk intervention.

Blockchain technology provides a crucial technical foundation for the coordination of credit flows. Leveraging blockchain’s immutable and traceable characteristics, the core enterprise’s accounts payable confirmation certificates serve as reliable digital evidence, reducing the risk of forgery or duplicate financing. At the same time, the digital certificates issued by the anchor enterprise after confirmation can be circulated through multiple levels of the supply chain to distant parties, enabling small and medium-sized farmers at

the end of the supply chain to obtain credit enhancement for financing based on the anchor enterprise's payment commitment, thereby reducing information asymmetry and improving access to financing.

Furthermore, credit flow collaboration requires the participation of diverse stakeholders and mutual recognition of results. In the county-level ecosystem, in addition to the internal ratings of financial institutions, government credit evaluations, assessments by industry associations, and professional evaluations by third-party credit reporting agencies should also be incorporated. By establishing a multidimensional, comprehensive credit evaluation system and promoting mutual recognition of evaluation results among financial institutions, it is possible to significantly reduce the costs of duplicate investigations and improve the efficiency of credit resource allocation.

4.3. Collaboration of Capital Flow

Capital flow coordination is the ultimate goal of financial services, and its core lies in ensuring the safe and efficient circulation of funds. County-level agriculture and manufacturing exhibit distinct seasonal and cyclical characteristics. Capital coordination requires financial institutions to flexibly tailor the terms, amounts, and repayment methods of credit products based on the actual production progress reflected in the information flow. This approach avoids liquidity risks caused by idle funds or maturity mismatches and achieves a precise alignment between capital disbursement and production cycles.

Second, to prevent credit funds from being diverted to non-productive sectors, the capital flow coordination mechanism must rely on smart contract technology to establish strict conditions for fund disbursement. After a loan is disbursed, the funds do not go directly into the borrower's account but are instead directed to upstream suppliers based on actual purchase orders. Upon receipt of sales proceeds, the funds flow directly back into a bank-designated escrow account and are prioritized for loan repayment, implementing closed-loop control through entrusted payments and designated usage. This ensures that the flow of funds operates within a closed system, both physically and logically.

Finally, to safeguard cash flow coordination, a risk-sharing mechanism involving multiple stakeholders—including the government, banks, and guarantee institutions—must be established. County-level financial risks possess a certain degree of systemic nature and are subject to force majeure; therefore, the coordination of capital flows cannot rely solely on financial institutions acting alone. It is essential to involve entities such as government-backed financing guarantee institutions and agricultural insurance companies. By establishing risk compensation funds and implementing innovative models such as “credit + insurance + futures,” a risk-sharing network for capital coordination can be formed, effectively reducing the risk exposure of any single entity and enhancing the resilience of the financial ecosystem.

4.4. The Closed-Loop Logic of the Collaboration Among “Information Flow, Credit Flow, and Capital Flow”

The collaboration among information flows, credit flows, and capital flows is not a unidirectional, linear process, but rather forms an interdependent, spiraling closed-loop logic. Information flows generate credit flows; authentic, multi-source, and heterogeneous data, after being cleaned,

integrated, and processed through models, crystallize into trustworthy digital assets that serve as the basis for credit assessment. Credit flows guide capital flows; dynamic and precise credit profiles reduce risk premiums for financial institutions, directing credit funds toward the county-level real economy at more reasonable costs and through more targeted channels; Capital flows feed back into the information flow: the processes of capital disbursement, circulation, and recovery themselves generate new, high-value financial transaction data. This data, acting as a new information flow, is fed back into the system, further enriching the credit profiles of market participants. This continuous cycle of “information flow—credit flow—capital flow— new information flow” continuously optimizes the system's risk control models and resource allocation efficiency, enabling the county-level digital supply chain finance ecosystem to become increasingly robust and prosperous through dynamic evolution.

5. Prerequisites for the Operation of the Collaborative Mechanism

5.1. Institutional Prerequisites: County-Level Governance Capacity and Policy Support System

The primary prerequisite for the operation of the coordination mechanism is a sound institutional environment; the governance capacity of county-level governments directly determines the success or failure of ecosystem development. First, robust top-level design is needed to incorporate digital supply chain finance into the overall planning for county-level economic development, break down departmental barriers, and promote the unconditional collection and conditional opening of government data. Second, it is essential to establish and improve a legal and regulatory framework for data rights clarification, pricing, and trading, clearly defining data ownership, usage rights, and revenue rights to provide legal safeguards for information coordination. Furthermore, the government should introduce targeted fiscal and tax incentive policies to support financial institutions and technology companies actively participating in ecosystem development, thereby reducing their trial- and-error costs.

5.2. Technological Support: Digital Infrastructure and Data Governance Capabilities

Technology is a hard constraint for achieving the collaboration of the three flows. County-level regions must accelerate the construction of new digital infrastructure, including improving rural broadband network coverage, advancing the construction of 5G base stations, and popularizing agricultural IoT devices, to provide physical channels for the real-time collection of underlying data. At the same time, enhancing the overall data governance capabilities of county-level regions requires not only building high-standard cloud computing centers and computing power networks but also cultivating professional data management talent to ensure the quality and security of massive amounts of data throughout its entire lifecycle—from collection and storage to transmission and application.

5.3. Organizational Guarantees: Incentive-Compatible Design for Multiple Stakeholders

The long-term, stable operation of the collaborative mechanism depends on balancing the interests of all participating stakeholders. Within the county-level ecosystem, a meticulous design of incentive compatibility is essential. For core enterprises, supply chain finance should be used to reduce their overall supply chain costs and enhance their control over the industrial chain, thereby stimulating their willingness to share data and credit information. For financial institutions, government risk compensation and technological empowerment are needed to effectively reduce their non-performing loan ratios and customer acquisition costs, ensuring their commercial sustainability. At the same time, it is essential to ensure that farmers and small and micro enterprises have access to tangible, low-cost financing. Only in this way can a reasonable mechanism for interest distribution and risk-sharing be established, preventing “free-riding” behavior and fostering a close community of shared interests.

6. Policy Implications of the Collaborative Mechanism

Based on the above analysis, efforts to advance the development of a county-level digital supply chain finance ecosystem should focus on the following key areas: First, take the lead in building a public service platform. Local governments should play the role of a “proactive government” by spearheading the establishment of a credible, comprehensive county-level digital supply chain finance service platform to serve as the physical vehicle for the coordination of the “three flows.” Second, accelerate the formulation of industry standards. Regulatory authorities should collaborate with industry associations to promptly issue data interface standards, credit evaluation guidelines, and operational manuals for digital supply chain finance, thereby eliminating technical and institutional barriers to cross-institutional cooperation. Third, implement inclusive and prudent risk supervision. In the face of new models brought about by fintech, regulatory authorities should

explore the establishment of a “regulatory sandbox” mechanism to allow a certain degree of room for error in county-level financial innovation, while strictly adhering to the bottom line of preventing systemic risks. At the same time, they should utilize regulatory technology to achieve penetrative, real-time supervision of fund flows and business compliance, thereby safeguarding the healthy development of the county-level digital supply chain finance ecosystem.

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