

How Can China's Financial Technology Promote the Low-Carbon Transformation of China's Manufacturing Industry in the Context of Carbon Neutrality: A Literature Review

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Abstract

Under the guidance of the "dual carbon" strategic goals, China's manufacturing industry, as a core sector of carbon emissions, is facing unprecedented pressure for green transformation. Problems such as high energy consumption, high emissions and financing difficulties are restricting the sustainable development of the manufacturing industry. In recent years, the rapid development of fintech in the field of green finance has provided new tools and paths for the manufacturing industry to achieve low-carbon transformation. This paper aims to adopt the literature review method to systematically sort out the research achievements at home and abroad on the promotion of green development of manufacturing by financial technology in the past decade, and focuses on analyzing its role mechanisms in green financing, green supply chain management, carbon information disclosure and policy response mechanisms, etc. By summarizing the existing research paradigms, this paper points out that there are still deficiencies in the current research on theoretical integration, method application and industry differences. This article aims to provide a theoretical basis and research clues for subsequent studies and offer useful references for policymakers and industrial practitioners.

Keywords: Fintech Carbon neutrality; Green finance; Manufacturing industry; Low-carbon transformation; Literature Review

1. Introduction

In recent years, against the backdrop of global climate warming and the continuous deterioration of the ecological environment, achieving a green and low-carbon transformation of the economy and society has become a widely recognized consensus among the international community. China officially proposed the "carbon peak, carbon neutrality" strategic goal in 2020. This goal not only poses challenges to the traditional energy structure but also requires fundamental changes in the development mode of manufacturing characterized by high energy consumption and high emissions^{[2][3]}. Manufacturing is the core area for China to achieve the carbon neutrality strategy, and its green transformation has become a key path for promoting high-quality development in China^[4].

At the same time, emerging digital technologies such as big data, artificial intelligence, and blockchain are developing rapidly, driving the financial industry to accelerate its digital transformation. Financial technology, as a product of the deep integration of modern information technology and finance, is accelerating the change of traditional resource allocation methods. The concept of fintech mainly refers to new business models, new technological applications, and new product services that are driven by emerging cutting-edge technologies such as big data, blockchain, cloud computing, and artificial intelligence, and have a significant impact on the financial market and the supply of financial services. Financial technology has played a role in enhancing information transparency, improving risk identification capabilities, and lowering financing thresholds in the green financial system^[5]. Moreover, financial technology expands the application boundaries of green finance in areas such as green lending, carbon footprint assessment, and green asset pricing, and also provides new solutions for manufacturing enterprises to obtain green financing and optimize resource allocation^{[1][6]}.

Based on this, this paper adopts the literature review method, focusing on the nested mechanism among "financial technology - green finance - green and low-carbon transformation of manufacturing", systematically summarizing the research progress, existing theoretical basis and action paths, and policy practices of the existing literature, aiming to construct a research framework from an interdisciplinary perspective, with the intention of providing a systematic review and theoretical deepening for this field.

In addition, while summarizing relevant research, this paper will also sort out the interaction mechanism between financial technology and green finance from an international perspective, enriching the theoretical basis and comparative reference. By constructing a three-dimensional analytical structure of "technical logic - mechanism nesting - policy practice", it strives to provide a systematic summary and policy recommendations for the financial empowerment path of manufacturing green transformation in China.

2. Theoretical Foundation and Mechanism Analysis

2.1 Analysis of the Motivations for Low-Carbon Transformation

Manufacturing, as one of the major sources of carbon emissions in China, has undergone green and low-carbon transformation under the "dual carbon" strategy, which has become a key direction for national policy promotion. At the national level, the construction of a green financial system has been continuously strengthened, including carbon emission trading mechanisms, green credit incentives, and green bond issuance, all of which provide clear policy guidance and resource support for the reduction of carbon emissions in manufacturing. Wang et al. (2025)^[3] pointed out that manufacturing carbon emissions exhibit structural and regional differences, and the carbon emission intensity is unevenly distributed among different industries. Therefore, policy tools need to be targeted and dynamic. Hou (2023)^[2] further stated that green financial policies are the "pulling force" for the low-carbon process of manufacturing, and their effects not only lie in financing support but also in guiding the optimization of the industrial structure.

At the same time, manufacturing enterprises themselves also face multiple pressures from domestic and foreign markets, environmental regulations, and social responsibilities. Green transformation for manufacturing is no longer an option but a necessity. For example, Xie & Shi (2025)^[4] through literature analysis indicated that the core logic of high-quality development of manufacturing is gradually shifting towards the "green + intelligent" direction, and the traditional high-energy-consuming path is no longer sustainable.

Therefore, under the dual drive of policy guidance and the spontaneous mechanism of the market, the transformation pressure and challenges faced by manufacturing enterprises have become increasingly urgent.

2.2 Core Paths of Low-Carbon Transformation

In the path of low-carbon transformation in manufacturing, the technical path and the financial path jointly constitute a "dual-wheel drive" mechanism. In terms of the technical path, green production processes, intelligent manufacturing, and industrial digitalization are the core. Kong et al. (2025)^[7] proposed that manufacturing digitalization not only optimizes the energy structure and production processes but also uses big data to predict emission risks and achieve pre-emptive carbon management. In addition, the promotion of green process technologies and the construction of green supply chains also provide possibilities for manufacturing enterprises to achieve "carbon reduction without production halt".

In terms of the financial path, green loans, green bonds, and ESG investment are becoming important forces in reshaping the financing structure of manufacturing. Fang & Ji (2024)^[1] found that the embedding of fintech significantly improves the identification efficiency and risk assessment ability of green loans, effectively solving the problems of difficulty and high cost in financing for green projects. Pan & Pan (2025)^[8] further proposed that the construction of the green financial policy system should be combined with the construction of digital financial infrastructure to achieve diversification and standardization of green investment channels. In addition, Cui (2025)^[9] pointed out that digital inclusive finance platforms have a significant role in improving the accessibility of green finance, especially at the level of small and medium-sized manufacturing enterprises.

The technical path and the financial path are not isolated but should interact and integrate. Zhan et al. (2023)^[10] starting from the industrial structure, constructed the "green finance - fintech - industrial structure upgrading" action chain, verifying the positive driving effect of the synergy between the two on the performance of green transformation.

In conclusion, fintech and green finance have a high degree of theoretical compatibility, and the service system they jointly construct is becoming a new driving force for the green and low-carbon transformation of manufacturing industries.

3. How fintech promotes the low-carbon transformation of manufacturing industries

3.1 The enhancing effect of fintech on the efficiency of green financing

Green financing, as an important financial means to promote the low-carbon transformation of manufacturing industries, its efficiency directly affects the implementation and matching of green projects. The traditional green financing system has significant information asymmetry and implementation costs in identifying green projects, assessing risks, and monitoring the flow of funds. However, fintech, especially the integration of big data, blockchain, and artificial intelligence, has effectively improved the accuracy and transparency of green financing.

Firstly, big data and artificial intelligence technologies can enhance the screening efficiency of green projects and the accuracy of environmental risk assessment, alleviating the "moral hazard" problem in green finance^[1]. For example, in the green credit review process, financial institutions can use intelligent risk control models to quickly identify the environmental attributes and carbon benefits of the projects, improving the approval efficiency.

Secondly, the application of blockchain technology in green bonds and green asset securitization has improved the traceability of project tracking, reducing the possibility of "greenwashing"^[11]. By building a green asset transaction information chain through blockchain, the entire process of data traceability from green certification to carbon efficiency monitoring is achieved.

In addition, digital inclusive finance has also enhanced the availability of green financing for small and medium-sized manufacturing enterprises. The inclusive finance platform includes small and medium-sized enterprises that have been excluded from the green financing system in the credit assessment model with controllable risks, alleviating their financing bottleneck problems^[9]. Studies have shown that the development of digital finance has a significant positive relationship with the carbon performance of manufacturing industries, indicating its green orientation in resource allocation^[13].

In conclusion, fintech, through the tripartite path of "data credit enhancement + intelligent assessment + chain monitoring", is reshaping the mechanism foundation of green financing in manufacturing industries, providing efficient and transparent financial infrastructure support for the low-carbon transformation^[5].

3.2 The Driving Mechanism of Financial Technology in Promoting Green Technological Innovation

The low-carbon transformation of the manufacturing industry cannot be achieved without the continuous innovation of green technologies, and the role of financial technology cannot be ignored. It not only optimizes the investment and financing support system for green technological innovation, but also brings dynamic feedback and precise matching to technological research and development.

On one hand, financial technology enhances the efficiency of financing, reducing the financing threshold and capital cost for green technology research and development enterprises, and stimulating the enthusiasm of enterprises for green innovation. Existing studies have shown that there is a high positive correlation between the development of green finance and green innovation investment, and the development of financial technology plays a dual role as an "efficiency amplifier" and a "risk controller" in this process^[14].

On the other hand, the data processing capabilities of financial technology platforms enable it to precisely match innovative projects with suitable financial products and promote the transformation and implementation of innovation through smart contracts. In the green credit mechanism, the strengthening effect of financial technology on "green traceability + credit constraints" has enhanced the incentives for enterprises to conduct green technological research and development^[10].

Furthermore, at the international experience level, research indicates that the combination of green financial mechanisms and financial technology tools has a positive impact on the stability of the financial system and the sustainability of green investment. This mechanism promotes the predictability and security of the flow of green innovation capital, thereby significantly enhancing the long-term investment willingness of manufacturing enterprises in green innovation.

Therefore, financial technology not only enhances the "supply efficiency" of green technological research and development support on the capital side, but also forms a "data-driven - credit enhancement - value loop" green innovation incentive path at the mechanism level^{[1][5]}.

3.3 The Path Mechanism of Financial Technology in Promoting the Optimization and Upgrading of Industrial Structure

The ultimate goal of the green transformation of the manufacturing industry is not only the reduction of carbon emissions, but also the optimization and upgrading of the industrial structure, achieving a development path that prioritizes both high added value and sustainability. The introduction of financial technology has become an important engine for promoting industrial upgrading.

Firstly, the collaborative innovation of financial technology and green finance has enhanced the efficiency of industrial capital allocation, enabling resources to converge towards green, efficient, and low-energy-consuming industries, promoting the benign restructuring of the internal structure of the manufacturing industry^[10]. Through the dynamic identification and hierarchical management of indicators such as carbon intensity and energy utilization rate on the financial technology platform, the allocation of financial resources has a greener orientation.

Secondly, intelligent investment and financing platforms guide capital to high-tech green industries such as intelligent manufacturing and green energy equipment manufacturing, promoting the extension of the industrial chain to "high-end green". Zeng (2023)^[12] pointed out that financial technology has become the core financial driving force for the transformation and upgrading of the manufacturing industry, especially in the green substitution of high-carbon industries, with significant effects.

Thirdly, relevant studies show that in the process of promoting the transformation of the manufacturing industry from the traditional path of "winning by quantity" to "quality and efficiency-oriented", financial technology not only improves the green productivity but also prompts traditional enterprises to reposition their value chains^[11]. The integration of financial technology and green finance provides financial channels and decision-making basis for the upgrading of the low-carbon value chain.

In conclusion, financial technology, with its efficient, transparent, and traceable mechanism, effectively promotes the optimization of the manufacturing industry structure, the clean-up of production capacity, and the reshaping of the value chain, and is a key leverage for building a green manufacturing system under the "dual carbon" goals.^{[5][13]}

4. Research Gaps and Future Research Directions

4.1 Research Gaps: Insufficiencies in the theoretical framework, mechanism identification, and practical dimensions

Although current academic research on financial technology enabling the low-carbon transformation of the manufacturing industry has achieved certain progress, overall, it still faces issues such as fragmented theory and limited analysis of regional heterogeneity.

From the perspective of the theoretical framework, existing research mostly focuses on green finance or financial technology alone, lacking systematic research on the tripartite collaborative path of "financial technology - green finance - low-carbon transformation of manufacturing industry". Most scholars propose that financial technology can promote the innovation of green financial tools, but have not deeply integrated the theory of digital financial innovation with the logic of industrial low-carbon development. A large number of literatures emphasize the importance of green financing efficiency, but have not integrated financial technology into their mechanism analysis framework.

Furthermore, the current research in this field is not comprehensive enough in analyzing the heterogeneity of low-carbon transformation of the manufacturing industry at the regional and industrial levels. The response capacity of manufacturing industry's green transformation to financial technology is limited by factors such as the level of digital infrastructure construction, the position of the industrial chain, and the intensity of environmental protection policies. Although a large number of literatures analyze the impact paths of financial technology in the green transformation of the manufacturing industry, they fail to form a comparative analysis of multiple levels, types of industries, and regions, making it difficult to support precise policy formulation.

Finally, research on the integration and innovation of green finance and financial technology tools is also relatively lacking. Kashif et al. (2025)^[15] pointed out the collaborative effect of green investment and financial technology tools on the stability of the financial system, but still lacks case experience and mechanism exploration at the levels of green credit risk control models and green financing paths.

4.2 Future Research Directions: Focusing on Theoretical Deepening, Path Innovation and Quantitative Evaluation

To further promote the in-depth development of this research field, future studies can be systematically conducted along the following three major directions:

4.2.1 Construct a multi-theory framework integration.

The green finance theory, industrial digitalization theory, and financial innovation theory can be integrated to establish a three-dimensional explanatory system covering "digital technology + green finance + policy response", promoting the

systematic modeling of the financial driving mechanism for the low-carbon transformation of manufacturing, and addressing the current theoretical fragmentation problem.

4.2.2 Strengthen mechanism identification and scenario analysis capabilities.

By combining methods such as the mediating effect model, hierarchical regression, and difference-in-differences, the role mechanisms of fintech in green financing, technological innovation incentives, and low-carbon governance of the value chain can be identified, and the data dimension can be expanded by introducing micro variables such as enterprise questionnaires and carbon emission accounting, to construct a scenario-based research path. For example, testing the impact of the "green credit + intelligent assessment" mechanism on green R&D investment at the enterprise level; analyzing the marginal effect of "fintech penetration rate" on the marginal effect of industrial green clustering at the regional level.

Through in-depth expansion in the three dimensions of theory, empirical research and policy, more solid and comprehensive academic support can be provided for fintech to assist the manufacturing industry in green transformation under the "dual carbon" strategic goals.

5. Conclusion

This article, based on the "dual carbon" goal, focuses on how fintech can assist the manufacturing industry in its green and low-carbon transformation. It systematically examines its mechanisms in green financing efficiency, green technological innovation, and industrial structure upgrading, and constructs a theoretical logical path of "technology empowerment - mechanism reshaping - structural optimization".

Research shows that fintech significantly alleviates the information asymmetry problem in green financing by improving financing transparency and resource allocation efficiency; at the same time, its integration in tools such as green loans and green bonds enhances capital support and incentives for green technological innovation. More importantly, fintech and green finance have jointly promoted the reconfiguration of the green value chain within the manufacturing industry, accelerating the industrial transformation towards high-end, intelligent, and low-carbon directions.

However, currently, the application of fintech in the green transformation of the manufacturing industry still faces issues such as incomplete theoretical frameworks, insufficient mechanism identification, and poor regional adaptability. Future research needs to further integrate green finance and digital finance theories, strengthen cross-level mechanism modeling, and construct systematic quantitative assessment tools to support more precise and effective policy formulation.

In conclusion, as an important driving force in the digital economy era, fintech is providing key support for China's manufacturing industry to build an efficient and sustainable green financial ecosystem. Its strategic value will continue to be prominent in the "dual carbon" process.

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