Research on the Impact of Digital Finance Development on a Green Oriented Transition of Manufacturing Industry

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Abstract. With the increasing severity of the global climate change, low-carbon transformation in manufacturing industry has become the key to sustainable development. Globally, the rapid rise of digital finance has had a profound impact on the economic structure and development transformation of manufacturing industry. The study focuses on how digital finance to influence on Low-carbon transition in manufacturing industry, deeply exploring the mechanism at work of digital finance in both financing and industrial upgrading. By theoretic analysis, it establishes the theoretic framework for digital finance promoting the transformation, illustrating the role and path of digital finance for a green oriented and low-carbon transition of manufacturing. Suggestions such as strengthening digital financial supervision, improving the regulatory system, developing advanced green technologies, and integrating production and education are proposed, which provides policymakers with a new perspective to speed up the low-carbon transition of the manufacturing industry. This is of great significance for promoting economic green development and improving international competitiveness of manufacturing industry.

Keywords: Digital finance, Financing constraints, Industrial upgrading, Green innovation.

1. Introduction

As the greenhouse gas emissions caused by human production activities continue to accumulate, global climate change has become a hot topic of concern for humanity. For avoiding these emissions increasing rapidly affect human survival and development, major countries are unanimous on reducing greenhouse gas emissions and signed the Paris Agreement on April 22, 2016. In China's 14th Five-Year Plan, it is clearly stated that the country will establish and improve a green, low-carbon, and circular economic development system, promote comprehensive green transformation in economic and social development, and contribute to achieving the goals of carbon peak and carbon neutrality. The report of the 20th National Congress of the Communist Party of China further proposed we should enrich and develop the connotation and strategic work of "carbon peaking and carbon neutrality", striving to achieve the goal of carbon peaking by 2030 and carbon neutrality by 2060. In this context, China's manufacturing industry, as the lifeblood of the country's economy, is also an important field in the construction of a modern industrial system. Its added value accounts for about 30% of the whole world, and it has ranked first in the world for 14 years consecutively. As the largest sector in carbon dioxide emissions and energy consumption, the transformation and upgrading of the manufacturing industry has become an important task for achieving the dual carbon goals. To fully implement the spirit of the 20th National Congress of the Communist Party of China, and foster the new drivers of green development, the National Development and Reform Commission, together with relevant departments, has revised and formed the "Guidance Catalog for Green and Low-Carbon Transformation Industries (2024 Edition)". Based on this catalog, local governments and departments can introduce and improve relevant policies and measures with the development priorities of their respective regions and fields, creating a favorable environment for the transition and development of the manufacturing.

In the era of the digital economy, based on advanced technologies such as big data, cloud computing, and artificial intelligence, digital finance has developed rapidly, which achieves fast and efficient financial transactions and services. It breaks through the spatial and geographical limitations of traditional finance and enables financial operations anytime, anywhere through mobile phones,

computers, and other terminals, which greatly saves time and expands the service group. Digital finance can conduct more precise credit assessments and risk management of customers through big data and artificial intelligence technology, further reducing financial risks and improving the stability of financial services. With the help of blockchain, big data, artificial intelligence, and other technologies, finance has been complemented and improved. There are many remarkable advantages compared with traditional finance in terms of efficiency, cost, coverage, risk management, and product innovation, making it better able to meet the financial needs of modern society. In the process of this transition, financial support is indispensable, and digital finance has highlighted its impact on the green and low-carbon transition of the manufacturing.

Although China is a large manufacturing country with a giant scale, it still can develop better in modern manufacturing. Under the pressure of the carbon peaking and carbon neutrality strategy, digital finance that deeply integrates digital technology and finance can better leverage its advantages in the low-carbon transformation process and support China's economic development strategy of "structural adjustment, stable growth, energy consumption reduction, and emission reduction". Studying the impact of digital finance on the low-carbon transition of the manufacturing not only helps to understand the internal connection between digital finance and the green transition, but also has far-reaching research significance.

This study focuses on exploring how digital finance to make impact on the green oriented development of the manufacturing through multiple aspects such as financing for low-carbon transition, promoting industrial upgrading, supporting green innovation technology, and optimizing capital allocation. Firstly, it explores how digital finance can broaden financing channels, reduce financing costs, provide stable financial support for the low-carbon transformation of the manufacturing industry, impact on promoting industrial upgrading. Secondly, it analyzes the mechanism of green innovation technology and optimizing capital allocation. Finally, it studies the path of digital finance supporting its transition of the manufacturing by supporting the implementation of digitization and green innovation, and promoting the development of the manufacturing industry in a low-carbon, environmentally friendly, and efficient direction. Based on the above research, the conclusion on the role of digital finance in the green oriented transition of manufacturing, and relevant policy suggestions are proposed.

2. The role and mechanism of digital finance development in the green oriented and low-carbon transition of manufacturing industry

2.1. The Role of Digital Finance Development for Green and Low Carbon Transition in Manufacturing

2.1.1 Financing

Digital finance refers to the emergence of new products, services, and business models resulting from the application of digital technologies such as the internet, big data, and artificial intelligence in the financial industry. The rapid development of digital technology has provided effective solutions to address the issue of information asymmetry between financial borrowers and lenders. On the one hand, digital finance leverages digital technologies like the internet to enhance the accessibility of funds. Shen and Tan have found that digital finance can expand the temporal and spatial boundaries of traditional finance, enhance the efficiency of corporate financing [1], and reduce carbon emissions associated with corporate financing activities. Simultaneously, digital finance itself can reduce various financial transaction costs [2], freeing up more funds for carbon-related activities and providing a practical and effective source of funding for the development and utilization of green energy. Existing literature suggests that corporate decision-making is influenced by the financial situation of the enterprise, and the easing of financing constraints can encourage enterprises to increase investment in digital technology research and development, promote independent innovation in digital technology [3], and achieve the abolition of "gray" production technologies in

manufacturing enterprises while developing green technologies. The rise of digital finance has also been accompanied by innovations in financial products, supporting the transformation of high-carbon manufacturing enterprises. Financial products have diversified and continuously integrated with green development, leading to the introduction of green bonds, sustainability-linked bonds, and sustainability-linked green bonds. Compared to traditional financial products with relatively fixed characteristics such as service scope and interest rates, innovative financial products not only facilitate the flow of funds to low-carbon industries but also address the financing difficulties of high-carbon industries during the low-carbon transition. The diversification of products provides high-carbon enterprises with financing options, enabling them to obtain further support from financial markets, develop the scaling and industrialization of green technologies, and facilitate the green oriented transformation of industries. On the other hand, digital finance expands and enhances the level of traditional financial services, more effectively meeting the development needs of industrial upgrading. By combining and deepening supply chain finance services, enterprises can optimize the business environment, attract foreign investment in China, support China's high-level opening up [4], introduce foreign direct investment, meet the needs of the real economy, and effectively resolve corporate financing difficulties. Therefore, the popularization and expansion of digital finance has increased the level of foreign direct investment in China, broken through financing constraints, and enhanced the level of foreign direct financing to advance the introduction of the green oriented technologies by enterprises.

2.1.2 Industrial upgrading

Based on the advantages of digital technologies such as big data and cloud computing, digital finance can support various enterprises with the willingness to undertake green technology innovation by forming innovative financing support effects and enabling cost efficiency of digital technology. With its unique digital inclusion supporting effects and low-cost financing effects, it can reduce information asymmetry and costs. By processing massive amounts of data at low cost and low risk, digital finance further optimizes its service targets, compensating for inherent issues such as "ownership bias" and "scale bias" in traditional financial financing targets [5]. To a certain extent, it effectively mitigates adverse selection, allowing groups excluded from finance to enjoy financial services at reasonable costs, strengthening the sharing and allocation of financial resources among various manufacturing enterprises, and further promoting digital inclusive finance. Digital inclusive finance is a product of the integration of finance and technology. Relying on technologies such as big data and artificial intelligence, it possesses strong capabilities in information acquisition, processing, and refinement. This not only alleviates the problem of information asymmetry between borrowers and lenders, reducing information costs but also disperses non-systemic risks. It significantly improves the efficiency of production factor allocation, providing a tremendous boost to industrial structure upgrading and enabling the rationalization of industrial structure development [6]. Additionally, by leveraging the internet, mobile data payments, cloud computing, and other means, digital finance enhances the efficiency of financial services. By lowering the investment and financing costs of energy companies, it can enhance the efficiency of green capital allocation, accelerate the flow of funds towards green and environmentally friendly fields, and promote the green upgrading of industries.

2.2. Mechanism Intermediary - Variables

2.2.1 Green innovative technology

Green innovative technology is an innovative activity aimed at achieving green development. This is of great significance for promoting the continuous development and innovation of green technology. On the one hand, in terms of human capital, with the popularization of digital finance and the penetration of digital technology, the market's demand for high-tech and highly educated talent continues to increase, optimizing the human capital structure and laying a solid foundation for green technology innovation. On the other hand, as a relatively well-developed and advanced

financial system, digital finance can enhance enterprises' external financing capabilities, alleviate financing constraints [7], and provide necessary credit funds. This helps to alleviate financing issues and promote the development of green technology innovation in the manufacturing. Green innovative technology, as an important factor affecting carbon emission performance, also significantly impacts the process of low-carbon transition in the manufacturing.

2.2.2 Optimizing Capital Allocation

Digital finance operates primarily through virtual branches, paperless offices, and contactless transactions, significantly reducing resource and energy consumption in financial services. This helps manufacturing enterprises save on transaction costs, freeing up more funds for their operations. By relying on big data for risk credit assessments and financing needs assessments, digital finance achieves instant peer-to-peer connectivity of financial resources, enhancing the structure and efficiency of resource allocation in financial services.

At the same time, with financial technology as its core, digital finance can play an active role in directing more funds and other essential factors, improving the financial industry's ability to serve the traditional economy. As production factors shift towards more efficient sectors, digital finance further guides capital towards green and environmentally friendly areas. By fully leveraging its capital-guiding effects, digital finance optimizes capital allocation, directs funds towards green services, expands the scale of green technology services, and foster the green and low-carbon transition of the manufacturing.

3. Main Pathways

3.1. Enterprise Digital Transition to Make Less Carbon Emissions

Enterprise digital transformation encompasses both the advancement of digital technology and its practical application within the enterprise [8]. The development of digital finance not only promotes the technological progress of digitalization within enterprises but also facilitates the practical application of digital technologies, thereby driving enterprise digital transformation. Longchi has shown that digital finance can reduce carbon emissions in manufacturing by promoting technological advancements and enabling enterprise digital transformation [9]. Through digital transformation, enterprises can introduce energy management systems to monitor and analyze energy consumption in real-time, identify energy waste, and take corrective measures. This helps optimize production processes, reduce waste and emissions, introduce smart manufacturing and the Internet of Things to monitor equipment performance, improve production efficiency, and lower energy consumption and emissions, ultimately promoting green and low-carbon transformation in manufacturing.

3.2. Enterprise Digital Transformation to Reduce Carbon Emissions

Zhang et al. propose that existing technologies cannot meet low-carbon requirements, and the achievement of energy conservation and emission reduction goals relies on the support of energy-saving technologies [10]. Green technology innovation undoubtedly promotes the development of energy-saving technologies and equipment, thereby increasing energy efficiency and make less reduction energy consumption per unit of production. This means that enterprises require less energy to produce the same quantity of goods. Since energy consumption is a primary source of carbon emissions, reducing energy consumption directly decreases carbon emissions. Additionally, some energy-saving technologies and equipment can further reduce emissions through waste recovery, reuse, and raw material conservation. Literature indicates a positive correlation between the number of energy-saving technology patents granted and the level of digital finance development. However, initially, these patents are influenced more by the breadth of digital finance, favoring production expansion, i.e., a significant production effect [11]. Later, as digital finance deepens and digitalization accumulates, more energy-saving technology patents emerge, leading to reduced carbon emissions.

3.3. Innovating Financial Instruments to Promote Green Investment

The popularization of digital finance drives the diversification of financial instruments, giving rise to financial tools such as green bonds and green funds specifically designed to finance green and low-carbon activities. Green funds focus on investing in environmentally friendly enterprises and projects, providing financial support to manufacturing enterprises and facilitating their transition towards a low-carbon and environmentally friendly direction. By issuing green bonds, enterprises can raise funds for developing green innovative technology, clean energy projects, and other initiatives, promoting the low-carbon transformation of manufacturing. Simultaneously, green bonds play a role in transmitting policy signals [12], indicating an enterprise's active fulfillment of green social responsibilities. This behavior enhances the green reputation and value of manufacturing enterprises.

4. Suggestion

4.1. Strengthening Regulation and Improving the Digital Finance Legal Framework

While digital finance has facilitated financing channels for manufacturing enterprises, it has also introduced new risks to the sector. Regulation, as the cornerstone of ensuring the stable operation of digital finance, requires the establishment of a scientific and effective regulatory system. This system should ensure the compliance and stability of digital financial activities through enhanced risk monitoring, early warning, and prevention. Simultaneously, regulatory authorities should actively collaborate with financial institutions to jointly promote the innovative development of digital finance, achieving a positive interaction between regulation and innovation. Advancing digital finance also necessitates the continuous improvement of the financial regulatory framework, including optimizing digital finance infrastructure, enhancing financial service levels, and strengthening financial data security and privacy protection. It is essential to conduct legislative or regulatory study on the frontier issues of digital finance, accelerate the establishment and improvement of relevant laws and regulations tailored to the feature of the digital finance industry, and integrate digital financial activities into the financial regulatory and competitive regulatory systems according to laws and regulations, thereby ensuring the healthy and stable development of digital finance.

4.2. Integrating Industry and Education to Strengthen Digital Finance Talent Cultivation

Talent is the key to the development and application of science and technology. As an effective talent cultivation model, the integration of industry and education offers numerous advantages. It enables resource sharing, introduces advanced technologies, equipment, and educational resources from the industry into the education sector, and improves education quality and efficiency. This approach cultivates students' practical abilities and innovative spirits, making them better suited to market demands. Currently, it is necessary to establish a close integration mechanism between industry and education, fostering deep cooperation between universities, research institutions, and enterprises to jointly develop green manufacturing technologies and boost deeply amalgamation of digital finance and manufacturing. The government should also introduce relevant policies to encourage and guide financial institutions, manufacturing enterprises, and educational institutions to participate in this integration. Through measures such as establishing special funds, providing tax incentives, and offering financial support, cooperation projects can receive funding and policy guarantees. Promoting the integration of industry and education will facilitate green technology innovation and development, ultimately achieving a low-carbon and green transition in manufacturing.

4.3. Continuous Innovation and Development of Green Advanced Technologies

The development of green technologies may have a lag effect and may not achieve significant impacts in the short term, but in the long run, it is beneficial for the sustainable development of enterprises [13]. This requires policies to encourage accelerated technological innovation, particularly

in green technology research and development, with a focus on cutting-edge technology research and exploration. Enterprises should be encouraged to increase investment in research and development, focusing on key areas such as energy conservation, emission reduction, clean production, and resource recycling, and develop green technologies with independent intellectual property rights. It is also important to strengthen management innovation and build a green manufacturing system. By improving the green manufacturing standard system, establishing green supply chains, and promoting green procurement measures, enterprises can be encouraged to adopt green practices throughout the entire process from product design, raw material procurement, manufacturing, to product sales. Additionally, strengthening the internal green culture of enterprises, raising employees' environmental awareness and responsibility, and fostering a good atmosphere of participation in green manufacturing among all staff are crucial. The government should impel enterprises to participate actively in green technology innovation and the green oriented transition in manufacturing through the formulation of green manufacturing policies, the provision of tax incentives and financial support, and other means. Furthermore, strengthening international cooperation and exchanges, learning from advanced foreign experiences and technologies, and jointly deepening low-carbon transition of global manufacturing can also be beneficial.

5. Conclusion

Digital finance is crucial to foster the green oriented transition of manufacturing. Its mechanism of action is primarily embodied in broadening financing channels, promoting industrial upgrading and technological innovation, and optimizing capital allocation. Through these mechanisms, digital finance provides strong financial support and momentum for the low-carbon transformation of manufacturing. In terms of path analysis, digital finance promotes the development of manufacturing towards a low-carbon, efficient, and sustainable direction by supporting the implementation of digitalization, intelligence, and green innovation in the sector. Simultaneously, digital finance offers diversified financing and support tools, providing multiple path options for the green oriented transition in manufacturing.

While enjoying the convenience and benefits brought by digital finance, it is essential to address the challenges and issues it poses. Relevant recommendations include strengthening regulation, establishing a sound digital finance regulatory system to prevent financial risks, and ensuring that digital finance operates within the boundaries of compliance. Secondly, improving the digital finance legal framework is necessary to provide legal guarantees for the development of digital finance and facilitate its deep integration with transition of manufacturing. Additionally, enhancing the cultivation of digital finance talent through the integration of industry and education can provide talent support for the low-carbon transformation of manufacturing. Finally, continuously promoting innovation and developing green advanced technologies are crucial for enhancing the green oriented transition capabilities and levels of manufacturing.

The low-carbon transition of manufacturing is a complex process that may involve the interaction of multiple factors and intermediary variables influenced by digital finance. This study has not delved deeply into revealing the complex relationships between these factors or their collective impact on the green oriented transition in manufacturing through modeling.

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