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The Low-carbon Transformation of the Manufacturing Industry Under The Dual Carbon Context

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Abstract:

This study explores how the development of green finance affects the low-carbon transformation of manufacturing industries under the double carbon goals by reviewing literature, conducting empirical testing, and applying cases to see the driving mechanism behind this process, and what impacts green finance has on the low-carbon transformation of manufacturing enterprises. It concludes that. The main influences on this sector include: The first aspect is green finance providing financial support for the low carbon transformation of the manufacturing industry through using green credit and green bonds, helping the enterprises to carry out emission reduction related actions including energy saving technological transformation and equipment renewal. Secondly, green finance promotes the use of more green finance products and services. under the impetus of e, empowered enterprise-land capable of developing low-power chips and high-energy-density batteries to improve energy utilization efficiency and reduce carbon emissions; utilizing e in green finance forced power-consuming manufacturing enterprises to undergo green transformations through a cost shift, endowing them with a comparative advantage as they accommodated green trade trends internationally, ensuring safety from carbon tariffs, yet concurrently certain problems such as regional imbalances in development of green finance where the eastern region's level of green credit accounts for more than 65%, the central and western regions are no higher than 40% was identified.

Keywords: Dual carbon goals; low-carbon transformation; manufacturing industry.

1. Introduction

Facing a severe environmental crisis all over the world, with climate solutions being globally encouraged, China must stop carbon emissions before 2030 and obtain carbon neutrality before 2060, a broad mission for the country. In order to make this high ambition plan turn into reality, the government is implementing effective programs of numerous policy frameworks. These plans include national carbon emission control guidelines, carbon trading schemes, and national indicators for measuring product carbon footprints. These steps are the key drivers for the entire economy to shift towards a low-carbon direction.

They mainly involve how to thoroughly develop manufacturing, which accounts for more than one-third of China's total emissions and energy consumption, being the largest in the world. This transformation is inevitable for China to fulfill its climate commitments. However, given the current high-carbon development status of this industry, traditional resource-intensive and carbon-intensive manufacturing methods may hinder China's progress towards carbon-neutral production. Therefore, the restructuring of China's manufacturing industry is crucial for a green future, prosperity, and global impact.

There is no doubt that this is urgent. Production accounts for approximately 70% of all industrial carbon emissions and more than 40% of the national total emissions. Such a huge carbon footprint means that carbon reduction is crucial for achieving China's overall climate goals. This is not only a matter of reducing risks but also a powerful incentive for promoting industrial upgrading. The adoption of clean manufacturing technologies by manufacturing factories helps enterprises increase productivity, reduce long-term operating costs, and enhance competitiveness in the international market. Additionally, clean manufacturing technologies help the country reduce its reliance on imported fossil fuels and improve national security.

On a global scale, can see that the financial sector is moving in this direction. Recently, green finance has flourished, and sustainable investment has grown significantly. For example, the global issuance of green bonds reached a record high of 688 billion US dollars last year, and is expected to increase to 700 billion US dollars by 2025. The trend in public markets is equally strong: for example, in 2023, the iShares Paris Agreement Climate Morgan Stanley Capital International (MSCI) USA exchange-traded fund (ETF) achieved net inflows of 950 million United States dollars (USD), with its assets under management (AUM) reaching 1.539 billion United States dollars. At the same time, the genetically modified climate change fund also received a large amount of investment, with an asset size reaching 827 million US dollars by the end of the year.

This advantage is also directly related to China's green finance development trend and the decarbonization efforts of the manufacturing industry; it provides unexpected financial resources as well as the resources needed for enterprises to reduce emissions and improve energy efficiency until they can become a more environmentally sustainable foundation [1].

This study analyzed the main intersections between green finance and China's manufacturing industry. Based on China's goals of carbon peak by 2030 and carbon neutrality by 2060, it discovered the potential of financial innovation to drive China's manufacturing industry towards carbon neutrality. By synthesizing the relevant existing literatures and empirical evidences, map the mechanism by which green finance can effect the transition, and attempt to offer elaborations to enrich the existing researches, as well as offering guidance to the policymakers for efficient policymaking, to the financial institutions for designing new products, and to the manufacturers for navigating their real-world journey toward a sustainable future.

2. Theoretical Research

2.1 The Connotation and Evolution of Green Finance

Green finance is at its core about aligning capital with planetary necessity. It concerns a broad array of economic activities and financial services intended to support the furthering of environmental goals, address climate change, and foster improved resource utilization. Green finance manifests through those very principles in the clean energy, sustainable transportation, and green building sectors in particular, the objective being for green finance to catalyze a sustainable future. However, it often operates in collaboration with tools that, although varied, ultimately boil down to four categories: impact assessment, green auditing, fundraising, and environmental assurance.

First is green credit, where banks and lenders channel capital exclusively to industries such as renewables and more eco-friendly forms of production in general, thereby making polluters pay by inflicting stricter lending requirements on the same, which forces them to factor in the costs they cause the environment to incur, making the allocation of credit more efficient, while also making low-carbon investments risk-free for investors. A large number of institutions have reserved designated amounts of green lending limits solely for this purpose.

While green bonds are gaining appeal as an effective way to raise the significant sums necessary for these type of projects. In regulated channels these are sold with proceeds targeted solely for green projects, where otherwise robust and well-capitalized markets can be lacking. Because of attractive supply meets strong demand in parts of

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the world without sufficient availability of long-term bank financing, green bonds enable access to diverse and potentially less expensive funding streams for producers with decarbonization ambitions.

Another way to make the finance sector support green development is with the help of "green insurance." It from two perspectives: in its rawest sense, it's a form of environmental liability insurance that covers all the expenses resulting from an accident of pollution; more broadly speaking, it's a broader safety net for the green transition, protecting policies such as against pollution risk, extreme weather conditions, and also some sort of protection policy for green technology and buildings and transportation [2].

And with the upsurge of the green economy, there arises carbon finance, which sets up a fund to reduce greenhouse gases. It involves financial activities or markets about greenhouse gas emissions allowances transactions and derivatives. These activities create an active market pricing carbon emissions, offering feedback signals and encouraging business investment in clean energy-saving technologies, promoting the second round of low-carbon innovation as well [3].

2.2 Analysis of Driving Factors for Low-Carbon Transformation in Manufacturing Industry

The process of moving towards low-carbon production is not a straightforward, linear journey along a single path; rather, it is driven by multiple factors - mainly from the outside to the inside, but the most convincing is from the inside out. Under the combined force from all directions, the industry is forced to adjust itself along a clearer and clearer path towards sustainable development.

Superficially, the conscious choices of policymakers and market forces fundamentally redefine this pattern. Governments around the world have set strict environmental goals and emission limits to force industrial participants to improve their behavior, otherwise they will face penalties. In addition to local regulations, developing countries that use carbon border taxes will also include carbon-intensive imported goods in the penalty scope, which will bring huge costs and thus weaken their competitiveness. To continue entering promising markets or participating in leading supply chains, changes are needed. Moreover, as the demand from consumers for green products drives the global distributed supply chain to change, green global trade is rapidly becoming the focus, and the partners are turning to those that can guarantee their ecological footprint. Therefore, over time, transformation will no longer be an option.

Finally, a strong business argument emerges: Technological innovation provides tools to do things differently, such as breakthroughs in renewable energy, energy efficiency, and clean manufacturing processes. Their adoption is certainly not green - some people will say it is almost certainly sustainable; this is also a good business strategy that can bring lower operating costs, better products (such as the placement and use of components), and better social responsibility.

When companies establish brands with environmental responsibility and receive better responses in terms of consumer trust and investment, they must reduce long-term operating costs to achieve profit targets. The reliance on limited and unstable resources (such as fossil fuels) puts great pressure on the company's profitability. Transition to renewable energies or become more energy efficient reduces the exposure to unforeseen cost increases for fuel and does not only hedge against price shocks but also provides predictability, securing a more favorable cost structure for the company.

In essence, it's driven by two engines—external factors, such as regulatory shifts and market evolutions, build the necessary impetus for a change, and internal forces, such as innovation, branding, and fiscal discipline pull it in. In fact, what makes change happen today is a perfect alchemy of the mandatory, i. e. regulatory pressures, and the motivating, i. e., innovation, branding, financial prudence.

3. Practical Analysis of Green Finance Supporting Manufacturing under the Dual Carbon Goals

3.1 Development Stage

The evolution of green finance for China's manufacturing sector is like a transformation from the notion into its present-day manifestation as an all-encompassing system.

In its very early stage (1995-2008), this notion was still a work in progress; the Eleventh Five-Year Plan officially included energy saving and reducing pollutant discharge among China's national policies and goals—the very first policy request for greening China's economy called upon green finance to address the country's most fundamental industry pollutant discharges. During this time, it was less a matter of sophisticated tools and devices than a strategic direction guiding the next few decades.

The second stage was the initial construction period of the system (2009-2014), during which the core objective was to establish a green credit statistics and evaluation system, initially regulating the direction of financial resources and providing an early system framework for financing green projects in the manufacturing industry.

A leap forward was made during the entire period from 2015 to 2020 which is an all-around improvement. The guiding opinion on building green financial system published by seven important government agencies in July

2016 is a big step in progress. It was listed the conversion of heavy-polluting manufacturing enterprises as one of the priorities. The key measures such as standardized catalogues, rigorous rules and mandatory environmental disclosure has corrected the fundamental market failure. It is because of this series of regulation that our country's green transition was actively promoted and led to the change in mentality from grudging "discretionary reduction" to the voluntary change [4].

Now have entered the deep-developing era (2021-present), during which policies become stricter and more efficient for the "dual carbon goals". In terms of the approach, it is more specific and authoritative by relating green credits and green supported projects to the measurement outcomes of evaluation index system; it strengthens the linkage among performance evaluations and mobilizes resources from all levels of government. The new "Green Bond Supported Project Catalogue " has expanded the scope to cover hotspots such as Carbon Capture, Utilization, and Storage (CCUS) technology areas. Most importantly, this stage breaks down the silos among green bonds, credit and carbon market, thereby enhancing synergy. Innovation measures such as carbon quota pledge financing provide an all-round one-stop service solution to facilitate the low-carbon transformation along the whole industrial chain.

3.2 Analysis of Regional Differences

In the process of green finance driving green development, significant regional differences are evident in China. Relying on economic and policy advantages, the eastern coastal areas have achieved large-scale and high-quality development in green finance, gathering over 60% of the country's green credit and over 70% of green bonds, with a focus on supporting technology-intensive high-end projects. For example, semiconductor companies in the Yangtze River Delta issue green bonds to develop low-power chips, automobile companies in the Pearl River Delta leverage green credit to tackle power battery technology, and Shanghai Petrochemical uses carbon quota pledge financing to build a CCUS project.

Constrained by economic and industrial structures, the central and western regions focus on "basic transformation and characteristic breakthrough" in green finance. Green credit accounts for only 25% of the national total, mostly invested in basic emission reduction fields, such as the transformation of desulfurization systems in central steel enterprises and the upgrading of waste heat power generation equipment in western cement enterprises. At the same time, relying on resources, they explore characteristic paths. The west supports the manufacturing of new energy equipment, while the central region assists agricultural product processing enterprises in upgrading clean production technology. However, the overall driving force is weaker than that in the east, and there is a shortage in the research and development of high-end green technologies.

3.3 Application of Green Finance Tools in Manufacturing Industry

Powered by the dual-carbon target, green financial instruments have promoted green transformation in the industry. As an important means of green finance, green lending requires that banking institutions include such evaluation indicators as reduction of pollution and resource utilization in its core evaluation standards of whether to issue loans to customers or not. The Industrial and Commercial Bank of China (ICBC) has launched a green housing mortgage product which gives preferential loan treatment to the buyers who buy the certified green buildings or other environmentally-friendly buildings [5]. This helps allocate financial resources for the industry's green transformation at the very beginning.

By contrast, green bonds open up a direct finance channel to fund the green upgrade of manufacturing sectors. Entities that sell green bonds thus attract specific funds earmarked for green-industry purposes. An example is Shenzhen's maiden three-year green bond climate themed green bond issued in Macau on September 9, 2025, with a coupon of 1.74%, which was channeled into sustainable urban transport and other clean infrastructure projects in the region. Green bonds enable companies to access funds for various green initiatives such as energy saving and emissions reduction and recycling resources by diversifying channels of funding and reducing their dependence on traditional indirect financing sources.

Carbon finance offers additional benefits to facilitate green change for manufacturing. Carbon allowances are now tradable assets because carbon emission trading systems are set up and corporations can monetize extra allowances by offsetting production emissions via new technology or investment, while buying from other companies with extra allowances if they are over their limit. For example, Kunshan Huachen New Energy Company Limited partnered with China Construction Bank Kunshan Branch to launch a special loan named "Carbon Quota Loan," which is issued based on the company's remaining unused carbon quotas.

These three green financial instruments work as one: they are reinforcing each other to provide the industry with a sustainable transition. Green credit provides short-term funds needed for green transition under indirect financing, while green bonds ensure long-term investment in projects on top of securing capitals from the green development perspective and reaching for green market via direct financing.

they link the broad array of fund gap problems that exist

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with respect to time frame and scale. In terms of incentives, carbon financial tools provide alternative cash flows for firms using the commoditization of carbon credits as a method of raising capital. After a company takes on a loan or bond to upgrade its operations and achieve emission reductions, it can sell any extra allowances to create a positive feedback loop of "finance-reduction-revenue." Banks can take carbon permits as collateral to offer carbon allowance backed loans, which reduce credit risk, and enable carbon assets to be effectively turned into financial resources. The integrated model of "financing + incentives + safeguards" drives the industrial manufacturing sector towards sustainable and low-carbon development.

4. Conclusion

The purpose of this paper is to research on the impact of advancing green finance on the transition of manufacturing industry toward low-carbon operation based on China's "dual carbon goals". In addition, the main methods involved in this study include literature review, empirical analysis, and case study. At first, analyze the background and the importance of this paper, point out the facts that manufacturing industries take up a big proportion of all greenhouse gas emissions and achieving carbon peaking and neutrality goals can't be achieved without the reduction of CO2emissions from the industries and green finance can offer capital, technology, so it has significant theoretical value and practical value.

After that study the theory underpinning the green finance, explain what is green finance, and introduce instruments like green credit and green bond. From an outside perspective, it analyse the drivers for the low-carbon transition of manufacturing such as policy regulation and carbon tariff; on the other hand, considering internal forces such as technological development and corporate social responsibility.

A practical evaluation for China's green finance policy transition focusing on 2016 and 2021 being the turning point years for China's development is illustrated in the following paper. A comparison between three regions: eastern, central and western China is shown. The eastern area stands out in terms of the scale of green finance provision. Meanwhile, the focus of green finance provision in the central and western regions lies more on their foundational structure and the creation of localized development models, albeit at a slightly slower pace.

The paper concludes that all the green finance measures have impacted the low-carbon transformation process in the manufacturing industry in different ways. Various problems need to be solved. The paper offers suggestions for stakeholders to push their low-carbon and decarbonization actions forward.

Looking forward, green finance plays an important role in promoting green transformation of manufacturing industry, guiding manufacturing industry towards efficient and suitable transition paths. The emphasis will change from general support to focusing on key areas. Green credit and green bonds will be tilted towards low carbon technology research and development and deep emission reduction for resource-intensive industries. Besides, green finance also helps to reshape manufacturing industry.

To include green design, cleaner manufacturing, and circular systems into supply chains. And to improve efficiency of manufacturing via digitalisation, to help reduce the costs of implementation. With the 2 Cs (carbon emissions, capital outlay) target sets, international competition, and pressures around reducing carbon footprint in production industries, green finance will assist in removing obstacles related to introducing low carbon technologies, aligning with international sustainable standard practice, and progressing towards attaining a modern green and low-carbon manufacturing system that maximises both economic benefit and environmental gain.

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