Green Finance's Carbon Emission Effects and Heterogeneity Under Dual Carbon Targets

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Abstract. The continuous deterioration of the climate in China and other places has raised public concern about air pollution. Therefore, in 2020, China set goals for the peak of carbon emissions and carbon neutrality, and building a green finance system has become one of the main policy choices to achieve these goals. Based on the review of relevant domestic and foreign literature, the three components of the impact of green finance on China's carbon emissions, namely the total emission reduction effect, transmission mechanism and heterogeneity characteristic, will be investigated in this paper. Based on the above analysis, scholars have empirically verified the restraining effect of green finance on carbon emissions, and the four main transmission channels are green technological innovation, optimisation of industrial structure, transformation of energy structure and environmental information disclosure. The effects of the policies differ systematically based on the level of economic development and urban structure in different areas. Generally speaking, the pattern is relatively stronger in Eastern China than in Western China, and the performance of industrial-upgrading cities is better than that of resource-extraction cities. The previous research has not standardised the green finance index and also fails to identify all routes in the chain of green finance. In the future, more research will be conducted at the micro-enterprise level, and attention will be paid to issues such as the synergy of digital finance and green finance.

Keywords: Green finance, Carbon emissions; Dual carbon goals; Transmission mechanism; Heterogeneity

1 Introduction

Global warming is one of the most serious problems in the world now. Since the beginning of industrialisation, large-scale combustion of fossil fuels has continuously increased greenhouse gas concentrations in the atmosphere. The world's average temperature has now risen more than 1.1 °C above the pre-industrial level, and as a result, there have been more severe weather phenomena, damage to ecosystems, and food security risks that threaten the continuous development of countries [1]. Given the above reasons, in 2020, China officially established the goal of peaking carbon emissions before 2030 and achieving carbon neutrality by 2060. It was also in line with the new direction of the global governance system for climate change and supported

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China's internal structural reform of the economy. It also means that China needs to complete a more dramatic rearrangement of its energy and industrial structure in a much shorter time than the developed countries did in history.

Given the background above, green finance has been included in the national strategy, and green loans and green debt instruments are being released to direct funds to environmentally friendly and carbon-neutral projects and promote the goal of reducing carbon emissions. In 2016, the seven departments and organisations released the "Framework for Building a Green Financial System" to lay the foundation for green finance. In 2017, the document on the construction of green finance reform and innovation pilot areas for all-weather policy experiments in Zhejiang, Guangdong, Guizhou, Jiangxi and Xinjiang was issued by the State Council; In 2021, the People's Bank of China released the carbon-emission reduction support tool and explicitly linked monetary policy to the goal of reducing carbon emissions. In 2024, some ministries and offices released joint guiding documents to strengthen financial support for green and low-carbon development and thus expanded the system of green finance policies [2]. With the modification of the policy system, the range of the first-line instruments for green finance and green debt has been expanding at a faster pace, and a substantial amount of funds have been directed towards decarbonisation-oriented industries such as renewable energy and resource-saving technology to support the green development of the real economy.

Studies on the Linkage of Green Finance and Carbon Emissions have gradually begun in recent years. The first analysis has only studied the direct effect of the volume of green loans on total carbon emissions. With the reform of green finance and the new pilot areas, Difference-in-Differences and spatial econometrics have been used to study the full effects of this policy; however, various studies have not yet reached an agreement on the channels of transmission or patterns of heterogeneity, and thus have been unable to spread the policy experience effectively [3]. At the same time, although discussions on the pattern of heterogeneity have been getting richer, there is still a lack of systematic integration of the internal logic among the various dimensions of differentiation.

Based on the above, this paper will systematically organise recent domestic and foreign empirical studies on the relationship between green finance and carbon emissions. It generally

Summarises the literature in terms of the overall effect of emission reduction, transmission path and heterogeneity pattern. Previous research on policy tools has mainly described the policies themselves or performed single-dimension analyses; however, none of the above studies have been carried out. Thus, will collect empirical results from many places to answer the three basic questions: where is it effective, how does it work, and who is more suitable for using it? This article aims to provide a comprehensive summary of the current research situation in response to this problem, offer a more specific reference framework for the further improvement of empirical studies, and provide a sufficient theoretical basis for policy formulation.

2 Overall Effect of Green Finance in Suppressing Carbon Emissions

2.1 Macro Level: Policy Instruments and Emission-Reduction Effects at the Provincial and Urban Levels

At present, it is generally agreed by scholars in China and abroad that green finance has promoted the reduction of carbon emissions. According to the analysis of provincial panel data, an increase in green loans can reduce CO2 emissions to a certain extent, and this result is reliable after controlling for the scale of the economy and energy efficiency [4]. Therefore, it can be concluded that the emission-reduction effect of green finance is not merely the result of an increase in the quantity of funds; rather, it requires both the rule-making nature and enforcement effectiveness of the policy system.

In line with the "2017 Green Finance Restructuring and Innovation Pilot Zone Initiative", some studies have used the difference-in-differences method to determine the amount of reduction in carbon emission intensity of the pilot cities. Based on the above analysis, the policy has reduced the carbon-emission intensity in these areas, and this effect has gradually increased over time and will probably continue indefinitely [5]. Some research has taken green bonds as an independent variable and found that the scale of green bond issuance is also negatively correlated with urban carbon emission intensity. The above are the two main ways that emission reduction can be achieved. It should be pointed out that different studies have made various assessments of the magnitude of policy effects, due to differences in methodology such as the scope of samples, selection of control variables and treatment of endogeneity; the stability of the results varies.

The differences in the type of Green Finance policies have also led to some cooperation at the macro level. As a new type of monetary policy tool, it will direct the central bank to lead credit support for banks in the fields of green energy, resource efficiency, ecological protection and carbon-reduction innovation to expand credit and guide financial assets towards decarbonization; compared with green credit that is based on spontaneous market adjustments, this kind of structural policy mechanism has "central bank credit endorsement plus commercial bank transmission" and is more focused in capital allocation [6].

2.2 Micro Level: Enterprise Financing Behavior and the Influence Mechanism of Carbon Emissions

Finally, the macro-level policy effect will only be achieved by changing behaviour at the micro-level of the enterprises. Therefore, in recent years, academia has started to expand the scope of research to the level of enterprises. According to the data of listed companies, the measures taken in the green financial reform and innovation experimental area have reduced the funds provided to high-polluting enterprises; as a result, these enterprises have reduced investment in high-carbon manufacturing capacity and increased efforts to promote energy-efficiency improvement, and thus their corporate carbon emissions have dropped sharply [7]. At the micro level, as shown in the path above, green finance does not directly change the behaviour of emission

sources; instead, at the stage of funding, it limits the capital access of high-carbon enterprises and thus alters their production conditions.

According to the division of enterprises, research has shown that the reduction effect of carbon dioxide in green financial indicators for listed companies in high-polluting industries is significantly larger than that for enterprises in low-polluting industries; the reason for this is that highly polluting industries are more likely to face financing constraints, and thus the marginal effect of policy transmission is more prominent. At the same time, for enterprises with good research and development capabilities, green finance can help them alleviate financing pressure during the process of green technological innovation, encourage an increase in the output of green patents and clean technology investment, thus reducing carbon emission density at the beginning of the production process [8]. The old high-carbon enterprises lack an innovation foundation, so they will have fewer opportunities to obtain green loans and will be constrained in expanding their production scale. This is also one reason why different studies have reached various conclusions about how to reduce enterprise emissions.

At the micro level, there are problems with the difficulty of data collection and methodology. Since there are no all-encompassing statistics on the carbon emissions of enterprises, the results of this study may be difficult to verify. It has not been determined whether the impact of the green finance measure on the company's voluntary emission reduction plan is due to this measure either.

3 Transmission Mechanisms through Which Green Finance Affects Carbon Emissions

The decrease in carbon emissions from green finance does not directly impact it; rather, it is via other reasons that it is affected indirectly. The four main transmission paths have been mentioned in the above research; however, their relative weight and interconnections have not yet been studied.

The technological innovation path has been verified the most extensively in the literature. Lowering the financing threshold for green technology research and development will encourage enterprises to increase the amount of funds they invest in the development of low-carbon technology. In areas with relatively advanced development of green finance, both the number of corporate green patent applications and the scale of clean-technology funds are higher than in the whole country. The aim is to reduce the carbon emission intensity of industry through technological innovation and, in practice, use the allocation of capital to subsidise "green" development and displace "brown" development. Green finance can lower the financing costs of green technology research and development and improve market access; thus, low-carbon technology development projects that were previously out of reach due to high funding thresholds can now be realised to reduce carbon emissions at the start of the production process [9].

Optimisation of the industrial structure is another good way. Restrain the sources of funds for the green development of high-polluting industries and increase the funds provided for low-carbon, high-added-value industries. The Durbin model for space is

also applied in this study to show that there will be a spillover effect to the surrounding area through the industrial chain and it will be positive. Green bonds will be utilised for the purpose. Mandatorily limit the funds that can be used for certain purposes, such as clean energy and low-carbon transport, and construct an end-to-end information disclosure system to solve the general problem of "greenwashing" in the application of green finance.

The Path of Energy Consumption Structure Change is relatively new. Green Finance Policies have promoted the development of Clean Energy in the Pilot Area to a greater extent. In line with the policy system for carbon-reduction financing instruments, credit will be granted to promote the development of clean energy, resource-use efficiency and environmental protection, carbon-neutral technology innovation, etc. The two work together to guide the flow of funds, and when the new policy changes the course of restructuring the energy system, it will be easier to achieve good results. However, some studies have found that the effect of energy structure adjustment is affected by local energy endowment conditions. In coal-rich areas, although there will be policies to promote clean-energy substitution, their path dependence and the time lag before the start of effect will be relatively long.

Among the four types of transmission modes listed above, the environment information disclosure channel is relatively more institutionalized and has gradually attracted more attention in recent years due to the changes in ESG reporting systems. With the implementation and strengthening of green finance policies, there has been an increase in the demand for corporate environmental information disclosure; as a result, generally speaking, green financing arrangements in the pilot area now require the submission of ESG information reports in advance. The two levels of emission reduction in the Institutional Arrangement are shown below. The first is direct constraint: Enterprises must build a complete system of carbon emission accounting and reporting, and in doing so, they are forced to be transparent about this information. The second is the market signal effect; when a company voluntarily releases ESG data, it can be judged by the public and investors to see how well the company reduces emissions and may face higher borrowing costs due to poor performance [10]. According to the above data, the proportion of voluntary ESG information disclosures by listed companies in green finance pilot cities is relatively high compared with non-pilot areas. To some extent, it can be seen that the green finance policy has stimulated the firm's disclosure of information. However, there has been relatively little systematic empirical research on this path so far, and many of the reasons for the lack of such research are still unknown.

4 Heterogeneity Analysis of the Carbon-Emission Reduction Effect of Green Finance

The diversification of the Green Finance and Carbon Emission Assessment System is still in its early stages at present. Some research has studied all sorts of patterns in how different regions, different cities, distinct industries and other areas respond to the same

policy from many sides. The above results can be employed to help the government better implement policies going forward.

Regional heterogeneity has been the subject of most research in the literature. Some research has found that the effect of decarbonisation on green finance is relatively strong in the eastern part of China and weak in the western part. The financial system in the East is relatively healthy and has strict environmental regulations; thus, green funds are more likely to be employed for carbon reduction projects, and compared with the West, the financial system there is weak and fewer effective policies have been released [5]. Regional analysis of green bonds also shows that there is a certain trend, and the degree of alignment with environmental policies may reduce the impact of these policies on economic development. It should be pointed out that some studies have been changed. Provinces with high initial carbon emission intensity will be in a better position to respond to the green finance policies and will therefore be affected to some extent by these policies in terms of strength and the need for green development; that is to say, the impact of the policy transmission effect from a weak financial foundation will be reduced. Therefore, it can be concluded that the mechanism for the formation of regional heterogeneity is not single or linear, and local condition variables should be added to the analysis.

There is also a difference in the types of cities. Green Finance Policy has reduced the emission of Industrial Upgrading Areas more than that in Resource-Development Areas. The industrial structure of the resource-based city is very high in high-carbon resources, and due to strong path dependence, it is difficult to alter the financing structure by policy; the release cycle of emission-reduction effects is also relatively long. In terms of administrative rank, the central city has a relatively large amount of funds and innovation elements; therefore, the speed at which policies are transmitted in the central city is much faster than that in the outlying areas, and many studies have confirmed this. More research has shown that cities led by the secondary industry and old industrial base cities have relatively weak carbon emission reduction effects compared with cities dominated by the tertiary industry and non-old industrial base cities; the reason for this is strong path dependence and transformation-cost pressure in their industries. It is a case of the "Matthew effect".

The Spillovers in space are also uneven. Although there have been some positive spillage effects in the surrounding areas of the green finance policy, there is also a risk of "polluting industry transfer"; that is to say, after high-carbon industries leave the pilot area, they may be distributed in weak-regulation areas on the periphery and spread carbon emissions spatially rather than reducing the total amount of emissions [11]. Coordinated regional advancement of the construction of the green finance system should be carried out to avoid losing the emission-reduction effect. Therefore, the effectiveness of the green finance policy will be determined by how well the cross-regional policy coordination mechanism is built at the same time. Relying only on the reform of green finance in one area will not help achieve the local emission reduction goals, and may even lead to an imbalance in the carbon-emission structure of the region [12].

5 Conclusion

Based on the previous literature review, it can be concluded that green finance has a relatively weak suppressive effect on carbon emissions, and the main transmission paths are technological progress and industrial structure changes. The effects of the policy differ in different Areas, such as regions and cities, industries, etc. And the reduction in carbon emissions in the eastern region has been relatively significant and industrial-upgrading cities. Recently, research has also been carried out on the transmission mechanisms for the pathway of energy structure change and the pathway of environmental information disclosure. However, the level of detailed mechanism identification is still lower than that of the first two pathways. In terms of heterogeneity, different areas have been developing at various speeds in financial development level, environmental regulation capacity and industrial endowments, etc., and thus their responses to the policy have also differed.

At present, there are still problems with the uniformity of indicators and systematic knowledge of mechanism pathways. There is no universal norm for the construction of an all-encompassing green finance index; therefore, various studies have used different indicators and are difficult to compare across studies. The relative weights and connections of the four transmission paths have not been studied systematically in terms of theory or experiment. It is to be known whether the above paths are replacements for or supplements to each other, and under what circumstances a particular path will be chosen first; these are all open-ended problems yet to be solved. The means of accumulation and cause identification at the level of micro-enterprises are also missing. Most current research is still at the level of provincial or municipal macro data and has relatively few fine-grained cases in terms of enterprise behavior.

Based on this study, other scholars will be able to build upon its foundation to research how to effectively link carbon trading systems with green finance at all levels and examine the impact of various policies on the emission behavior of industries; at the same time, they can also explore how new digital financial tools may promote more efficient allocation of green financial products. With the start of the dual-carbon goals, new theories and applications will be developed in this field.

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