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Green credit policy and ESG performance for promoting sustainable economic system

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Abstract: Environmental, social and governance (ESG) goes beyond its function as a business to maximize profits for the shareholders to work for societal purposes. Meanwhile, the green credit policy in China is still in its infancy, and the impact of green loans on the efficiency of commercial banks is significantly different. In this context, this paper details the company's performance in crucial aspects such as low-carbon operations, eco-friendly financial innovation, a sustainable economic system, data security and the development of organizational capabilities to provide a sustainable development paradigm for supply chain finance technology peers. Based on ESG portfolio, we found that adding ESG holdings to a company affects its compliance with delivery or environmental rules, and anode and cathode of ESG combined Dual Carbon (DC) are presented in terms of emission levels. Our further research indicates the implementation of Green Credit Guideline has a positive impact on ESG performance of both green and polluting firms in comparison with others. The result was fully supported by different methods and models including PSM-DID (Propensity Score Matching-Differences-in-Differences), QDID (Quantiles Differences-in-Differences), and Kernel approaches, which can provide more implications and references for policy makers. Investors, politicians, and other essential stakeholders perceive ESG as a strategy to protect enterprises from future risks.

Keywords: green credit policy; ESG portfolio; sustainable economic system; dual carbon

1. Introduction

ESG (Environmental, Social, and Governance) performance and financial performance of corporations from developing and established nations are examined in this study, taking into account institutional, cultural, and legal variations among countries (Garcia and Orsato, 2020). With the growing social focus on sustainability, more and more investors are focusing on ESG performance. When investing in the oil and gas industry's megatrends, ESG investment quickly becomes one of the most recognizable and lasting (Shao et al., 2020). Environmental pollution emissions and cross-sectional socioeconomic data are the basis for Chinese prefecture-level and direct-controlled municipality administrative unit studies to understand better the regional geographic pattern of green development and environmental governance in China (Zhang et al., 2020). Due to fast economic growth, most resource-based towns in China are experiencing a growing conflict between their social economy and the natural environment. For resource-based cities, a well-coordinated growth of the social economy and natural environment is essential (Li et al., 2020). Air pollution,

particularly haze pollution, is a major environmental issue that directly impacts China's ability to maintain and expand its economy. The preliminary separation of components is accomplished by the use of the factor analysis approach (Wu et al., 2020). The study identified two primary types of influences: economic and environmental, in terms of factor identification findings.

Further, projects for renewable energy, water purification, recycling, and public transportation are all encouraged by China's green financing regulations. A seamless transition to a low-carbon and sustainable future is made possible through green financing (Lee, 2020). Environmental management systems have the potential to be critical in the fight against pollution in our environment. This research examines how China's regional green growth is affected by environmental decentralization and local government competition in light of the country's fast economic growth and increasing pollution (Wu et al., 2020). Environmental disclosure, one sort of voluntary environmental legislation, is critical in raising businesses' environmental consciousness, which in turn helps them grow more sustainably. This conclusion is based on the social responsibility and annual reports of China's most polluting listed firms (Xiang et al., 2020). Economic growth and environmental conservation have become vital in many emerging nations. Political and technological solutions must be considered while dealing with environmental challenges. However, environmental challenges must be addressed at the regional level due to variances in geography, climate, and economics (Liu et al., 2020). Environmentally friendly and polluting businesses are becoming more dependent on green credit, which regulates the flow of social capital to improve environmental governance and encourage green production in society. As a case study, this article examines the asymmetric effects of China's green credit policy and development in terms of debt financing costs and maturity (Xu and Li, 2020). China's energy consumption is divorced from its economic development, and the local government does consider the environmental costs of renewable energy; therefore, this transformation cannot be seen as sustainable (Guilhot, 2022). Developing low-carbon cities in China is an essential attempt to integrate China's national objectives for climate change governance with the actions of local governments. Such a pilot project is being undertaken to boost low-carbon growth and policy innovation. However, the importance of nested structure has yet been wholly grasped (Q. Song et al., 2020). China's fast urbanization has increased city populations, pushing the construction sector to work harder to keep up with demand. To combat climate change, the construction industry must be considered. This research first aims to investigate establishing a green transition route for the Chinese construction industry based on national and local low-carbon initiatives (L. Song et al., 2020). Diverse interest groups, including the national government, municipalities, garbage pickers, and households, are waste suppliers in a new household waste management system (Fuss et al., 2020). The model determines a policy-dominated industrial restructuring path. Sustainable development policies, adaptation to China's national industrial growth trend, and regional equality among the country's provinces are all integrated into one comprehensive framework (Wang et al., 2020). When a state's economy grows, so does its ability to tap into the nation's energy resources. The industrial revolution in China is no different. China's economy relies heavily on the global energy market,

one of the world's major oil importers and users. There is a clear correlation between the rise in output and population, climate change, and the development of alternate energy production methods (Zhang and Lis, 2020). Across the globe, various research has examined the effects of antibiotics in the environment and the effects of antibiotic residues in ecosystems. Because of the widespread misuse and overuse of antibiotics, they are now found in higher environmental concentrations and are more easily spread from person to person. We know that using antibiotics for non-medical reasons harms the environment and human health today (Serwecińska, 2020). A person's immediate physical surroundings include their home, their neighborhood, and their city's built environment. Various health outcomes, such as physical activity, may be impacted by the physical environment in which individuals live. More exposure to urban physical settings may improve human mental well-being (Kang et al., 2020). According to the "dual carbon" goal, China decided to contribute to strengthening objectives and a long-term low greenhouse gas emission development plan for the middle of the twenty-first century. There is a gradual transition from a rapid increase to a steady decrease when anthropogenic inputs and sinks are balanced out (Chen and Liu, 2022). However, little research has been done on how much particulate carbon falls as rain in Chinese cities. Particulate dual carbon concentrations, fluxes, stable carbon isotopes, and radiocarbon were measured, as were concentrations of certain cautions and some stable carbon isotopes and radiocarbon, to determine its properties and origins (Niu et al., 2022). The combination of ESG concept and low-carbon industry is not only a trend, but also one of the important factors to promote sustainable economic development. Investors realize that incorporating environmental, social, and corporate governance factors into investment decisions can deliver long-term value and sustainable returns. At the same time, the national government promotes the development of low-carbon industries by formulating relevant policies and guidelines, such as providing tax incentives, financial support and setting emission reduction targets. To sum up, the combination of ESG and low-carbon industries is gradually gaining widespread recognition, and investors are taking a strong interest in it and making investment decisions according to national policies. This trend will further promote the development of sustainable development and low-carbon economy, and bring prosperity and sustainable economic environment to the country and society. Investors have a key role to play in this trend, and their actions are helping to move the economy in a more environmentally friendly and sustainable direction. Inspired by ESG and low-carbon performance, we have directed our research interest toward searching for approaches to strengthen the governance of environmental issues and raise the importance of enterprises and individuals to ESG issues.

2. Literature review

2.1. Related work

As the global environment deteriorates, and ESG issues have shown strong domestic and international attention, addressing ESG issues has become a key part of business strategy. Lokuwaduge and Heenetigala explored the ESG reporting of companies in the metals and mining industries listed on the Australian Securities

Exchange to determine the nature of ESG metrics used in the industry (Lokuwaduge and Heenetigala, 2017). In response to the imperfection of the current ESG disclosure system, Oh SK discussed this. He found that many of these systems are not clear about the objects specified, and there are insufficient disclosures, and he proposed that everyone should have a certain understanding of current ESG global issues, which plays an important role in environmental governance issues (Oh, 2021). ESG systems have received much attention in recent years as issues such as climate change, labor conditions and corporate responsibility have grown. However, relevant comprehensive research is still insufficient, and the environmental, social security and management system has attracted much attention. Because the construction of the financial ESG system is of great significance, Ochi sorted out the definition and evaluation standards of ESG, summarized the international exploration and practice of the ESG system, and innovatively proposed the essence of the financial ESG system. He explored the construction of financial ESG indicator system, and deeply analyzed the implementation and existing problems of ESG in China's financial field (Ochi, 2021). Lagasio and Cucari pointed out that, where disclosure is voluntary but not arbitrary, the opinion contributes to ongoing disclosure. Debate on the issues of corporate governance mechanisms leading to more ESG disclosures, and highlights the need for a new approach to these issues (Lagasio and Cucari, 2019). ESG information disclosure system is inherent in the implementation of a corporate social responsibility (CSR) strategy. The level of quality of sustainability reports prepared by companies may increase their credibility, which in turn affects stakeholder perceptions, thereby enhancing corporate reputation. MD Odriozola applied a logistic regression for Ibex35 companies and we found that the quality of sustainability reporting increases the likelihood of a higher corporate reputation (Odriozola and Baraibar-Diez, 2017). Yuan et al. (2022) explained CSR assisted ESG information on Chinese listed companies' financial abnormalities is released and tested to see how the strength of internal and external oversight affects this. Quantifying the extent of ESG disclosure, non-financial information is employed rather than corporate social responsibility performance. ESG disclosure has been shown to promote corporate governance, public scrutiny, and government regulation, according to the research. To decrease financial fraud, the authors of this research believe that public disclosure of ESG factors is essential.

Zhang et al. (2021) proposed the study examines the heterogeneous performance of ESG investing in China when the Guideline for Establishing a Green Financial System announced. There was no difference in abnormal returns between high and low ESG portfolios; however, this has changed. An explanation for the company's outperformance is apparent. Next, the stock analysis demonstrates that companies with strong ESG scores are likelier to have more significant excess returns. Other than increased profitability, the growing performance of strong ESG companies is heavily reliant on an equity cost advantage. Khan et al. (2020) detailed that public-private partnership investments in energy and technological innovation affect China's consumption-based carbon emissions. The Generalized Least Squares (GLS) based Unit Root Test (URT) is used in this study to demonstrate the integrating relationship between public-private partnership investment in energy, technological innovation, green energy usage, export, imports, and consumer carbon

pollution. Their results show consumer demand, public-private partnership investment, and technological innovation are the primary drivers of Chinese carbon emissions, highlighting the need for greener manufacturing processes and more public-private investment in renewable energy sources. Chang et al. (2021) further introduced Data Envelopment Analysis (DEA) approach on panel dataset; this study analyses how digital finance and ESG performance interact to improve corporate financing efficiency. According to our empirical data, corporate financing efficiency is boosted at a significant level by ESG performance and digital finance, and digital finance alleviates the positive marginal effect of ESG performance on financing efficiency. Chen et al. (2022) explained the constructs of a difference-in-differences (DID) model according to the Green Credit Guideline (DID-GCG) to investigate low-carbon technology innovation in business and how it is influenced by green finance regulations. It's been shown via mechanism analysis that green finance policies encourage low-carbon technology innovation by enhancing businesses' investment and management efficiency. This research offers data to promote energy saving and emission reduction in developing nations. It helps policymakers better understand the influence of green financing policies on low-carbon technological innovation.

2.2. ESG portfolio

To achieve a win-win scenario based on resolving conflicts between various contradictory issues, turning contradictions into means of collaboration is a critical component of the three-pronged approach. That public engagement in environmental governance can help resolve disputes created by environmental issues involving numerous stakeholders, such as people, township grassroots governments, and rural production and operation cooperatives. Different degrees and phases of co-governance are often used in governance theory to create numerous co-governance topics, such as the government, social organizations and groups, the market, and individual individuals.

Through public participation in environmental governance, different stakeholders can build closer cooperative relationships and jointly address the challenges posed by environmental issues. Governments play an important role in this process, coordinating cooperative actions and providing relevant policy guidance. At the same time, social organizations and groups are also playing a positive role in promoting the participation of all parties in environmental governance by mobilizing and organizing social resources. Market mechanisms can also provide economic incentives for individuals and businesses to take positive action in environmental protection. In the process of cooperative governance, all parties should adopt an open and inclusive attitude and establish mechanisms for mutual trust and cooperation. In this way, different stakeholders can consult, collaborate and share information to develop workable solutions and share responsibility for environmental governance. Through cooperative governance, the interests of all parties can be maximized and a virtuous cycle of environmental protection and sustainable development can be promoted.

In a word, it is the key to solve various contradictory problems to transform contradictions into means of cooperation. As an important way of cooperation,

public participation in environmental governance can promote cooperation among different stakeholders, create diverse governance themes, and achieve win-win goals. By working together, we can build a harmonious and sustainable environmental governance system that benefits social development and people’s well-being.

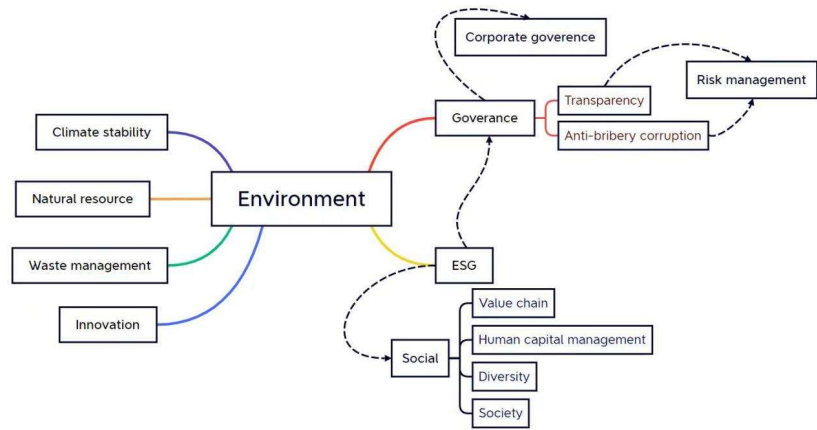


Figure 1. Overview of ESG portfolio.

Figure 1 illustrates companies that meet the ESG standards (Environment, Social, and Governance) are considered socially responsible by investors. It is called governance when an organized society governs a social system by its rules, norms, authority, or language. The term “social” refers to someone or anything that appreciates spending time with others or has something to do with groups of people. The whole of our physical surroundings is referred to as the environment. Stabilizing the climate is critical to the survival of Earth’s species. To mitigate the harmful effects of climate change on people, ecosystem conservation, management, and carbon sequestration measures are essential. Natural resources include air, sunlight, moisture, Earth, stones, flora, creatures, and coal power. All sorts of garbage are dealt with through waste management, including industrial, biological, domestic, municipal, organic, biomedical, and radioactive waste. When a concept is put into practice, it is considered an innovation. Businesses use this term to describe a strategy implemented in the marketplace that resulted in new profits and growth. The word “value chain” refers to the entirety of an operational business generating an item or brand, from obtaining raw materials to delivering the final product to clients. By investing in people, firms can increase their value in the long run, which is the goal of Human Capital Management (HCM). Corporate governance relates to how businesses are handled and controlled; the board of directors manages their companies. By electing directors and auditors, shareholders may ensure that the company has an effective governance structure. Identifying, analyzing, and reducing the financial, legal, strategic and security risks to a company’s capital and profitability are all part of risk management.

According to an unprecedented joint statement issued by more than medical, worldwide public health in ESG is threatened by climate change as the “most significant hazard; global climate conference saw a dramatic increase in the importance of human health as a topic of discussion. It is becoming more critical for firms in the industry to concentrate on decreasing their operational footprint and

addressing the health implications of climate change as part of a more extensive ESG waste management. Human health has joined health care ESG coalition groups such as the countrywide Healthcare Anchor Network to cooperate with organizations on social determinants of health, particularly those influenced by environmental challenges.

Healthcare and life sciences firms must demonstrate resilience in times of crisis, both as first responders to human health crises and as businesses committed solely to health and wellness. Further healthcare come to fruition without organizational-level reforms to become more climate-resistant ESG. While addressing global challenges, healthcare and life sciences companies should actively engage in environmental protection, social responsibility and good governance practices. To remain resilient to environmental risks such as climate change and natural disasters, these companies need to act sustainably. Reducing carbon emissions, efficient use of resources and promoting the adoption of renewable energy will help mitigate the negative health impacts of climate change. In addition, healthcare and life sciences companies should promote environmental awareness, such as practices to reduce waste generation, optimize waste disposal and promote a circular economy. Third, as part of society, these companies have a responsibility to contribute to community and public health. They can fulfill this responsibility by providing affordable care, supporting health education and prevention, and participating in public health advocacy. In addition, healthcare and life sciences companies can improve the overall health of society by promoting social equity, eliminating health disparities and improving the allocation of health resources. Finally, good governance is key to ensuring the sustainability of healthcare and life sciences companies. Transparency, ethics and effective corporate governance are all cornerstones of trust and stability. These companies should ensure ethical operations, compliance and anti-corruption practices, maintaining positive communication and cooperation with stakeholders. Meanwhile, the establishment of independent oversight bodies and internal control systems will help reduce risks and improve organizational resilience.

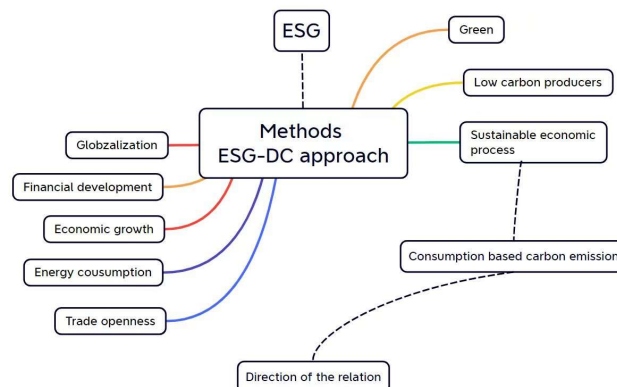


Figure 2. ESG-DC process.

Figure 2 illustrates the relative decoupling of economic development and carbon dioxide emissions through carbon peaking to carbon neutrality. Carbon dioxide emissions per unit of GDP (Gross Domestic Product) in my nation will fall per cent compared to current levels, non-fossil fuels will account for over a billion

kilowatts of primary energy consumption, and the country will be carbon neutral by the time it reaches its carbon emission peak. There will be a decrease in energy consumption and ESG as a percentage throughout this period. Energy and power system decarbonization and electrification, and the use of low-carbon fuels in places that cannot be electrified, are the primary ways to achieve carbon neutrality in the future of ESG. To reach carbon emissions peaking shortly, China has been pursuing a more sustainable and equitable economic development mode in recent years. China has the enormous burden of leading the “green revival” of the global economy since it is the only major country to achieve positive growth. Approximately a third of the world’s entire economic production and a quarter of its total carbon dioxide emissions will be produced in China. The muscular national comprehensive strength has built a solid economic basis for accomplishing the “dual carbon” target in China’s overall economic volume. To reach carbon peaking and carbon neutrality, a significant amount of work must be done to reform the economy, society, and the Party Central. The committee is well-prepared for this crucial exam. Compared to other industrialized nations, China, the pressure to complete tasks in an increasingly constrained amount of time is mounting, and the “dual carbon” aim requires challenging work. Adaptation needs both bravery and knowledge to conquer adversity. Creating a sustainable future requires a lot of work and a fresh way of looking at things.

China’s 2018 Environmental Economic Work Conference highlights the development requirements of the National Assembly. At the party’s national congress, pollution prevention and control became one of the three major struggles to build a well-off society in an all-round way in the next three years. Carry out a wide range of land management, manage capital investments by state-owned companies, private companies, foreign companies, groups, entities and social organizations, and manage specialized companies in the field of environmental protection and reconstruction. As the main financial institution for green loans, the central bank has issued a series of major opinions on green loans through the central bank. The development of green loans for Chinese commercial banks is still in progress. There are many problems in the management of green loans, the enrichment of green products and the improvement of the system, which bring many potential credit risks to commercial banks. Therefore, it is very important to study the development of green credit combined with ESG and its impact on investors.

2.3. ESG and green credit

2.3.1. Advantages and disadvantages of green credit

The decisions of large companies and investors have a major impact on the achievement of the UN Sustainable Development Goals. Steps need to be taken to change the behavior of large companies and investors, and this is one of the key factors in changing their behavior. Provides information that influences people’s decision-making process. In these specific cases, both social and managerial performance will have a large impact (Su et al., 2020). Investors drive superior ESG performance and companies have a greater ability to improve ESG performance and vitality. But the company’s financial statements are conflicting, and some are even

the opposite, and ESG reports are hard to find. The report's global sponsor developed these metrics for stakeholders. Last year, the first sustainable accounting standards were published. While it's still in the works, it's going to be difficult for investors to do because the number one issue right now is that companies need to comply with this norm. And finally, national financial regulators must guide companies to do the same. China proposes to be reviewed by the National Commission for Corporate Social Responsibility and to formulate norms for the National Securities Exchange and Financial Markets Commission. Sustainability accounting standards will make these provisions applicable to all businesses that transact domestically. Finally, the most important thing is that government departments should establish information standards and mandatory reporting requirements, and establish corresponding financial information norms through accounting standards. Otherwise, that information will become the lack of financial information system (Wu et al., 2020; Chen et al., 2023).

Discussions about ESG investing continue, and the factors included in investment decisions mean they can affect the outcome. According to the Resource Dependence Theory, influential stakeholders will be those who have the ownership or control of resources that are crucial to the success of the organization. If enterprises believe those influential stakeholders attach importance to the attributes measured by ESG ratings, they are more likely to "comply and implement" (Chen et al., 2023; Hsu et al., 2020). As influential stakeholders, banks would be more willing to provide loans under specific conditions with more environmental information. Further, strengthening investment in ESG performance can increase enterprise value (Dessau et al., 2018; Lehner and Mizubuti, 2017; Gioia and Corley, 2002), and ESG score or rating is positively correlated with financial performance (Zhao et al., 2018; Ouni et al., 2020; De Lucia et al., 2020; Lee and Isa, 2020). The information in the literature also explains the current problems of ESG, and introduces the impact of ESG which can be explained in a graphic way. However, some studies suggest that in the long run, companies with good ESG practices will have lower costs of capital, less volatility and less corruption, corruption and fraud. In fact, it is the link between the Economic Action Group and financial performance and timing. First, it doesn't degrade performance, but there's plenty of evidence to help improve performance. Professor George Salafim and many of his colleagues have done a lot of work in this area. Banks can certainly improve their financial performance in matters related to their certified financial performance. The key word here is "important". Of course, if a company pays a lot of attention to the ESG of each entity of interest, financial performance will decline. While the focus on advertising, marketing, production capacity and R&D (Research and Development) will not change significantly, the appropriate level of investment within the Economic Action Group will help improve the financial performance of these industries. These studies, then, show that the improvement in ESG effectiveness is not months, but years. Therefore, companies and investors looking to benefit should consider long-term interest rates. In several countries, such as the United States and China, capital markets are too short-sighted to often solve this problem alone (Ahmad et al., 2021). Asset owners encourage asset managers to integrate into the economic agenda, and governments should create tax incentives to promote long-term growth. The management

committee should support the executive director with a long-term perspective.

It supports the integration of ESG elements into practical solutions for companies and investors, but the concept is relatively new in emerging markets and China, in other words, people must overcome the difficulties that the European economic agenda is depressing financial performance. Reliable information wanted to be obtained, but the company’s reporting system was not perfect. Investors have no experience with ESG etc. The challenge for China is that asset management is still a nascent industry and these companies will continue to learn and develop (Naimy et al., 2021). Unlike the industrial market, asset managers only trust asset managers and don’t even know what ESG is. Investors who see the importance of these factors can finally find an opportunity to evaluate a company’s performance (though not comprehensively) (Lee et al., 2018), but there is still a lot of work to do. It will help clarify important business and strategic issues, and this type of work is supported by the largest multinational corporations (Di Tullio et al., 2019).

Green loans have both positive and negative effects on banks’ financial performance. On the one hand, the development of green loans by commercial banks can help improve social image, achieve differentiated competition, manage environmental risks, and have a positive impact on bank efficiency (Zhuravlev et al., 2019). On the other hand, commercial banks develop green loans and increase operating costs. Also, discounts may be lower due to positive externalities of green projects. This did nothing to improve the bank’s financial performance (Sergeant et al., 2017). Exploring these issues is crucial for evaluating the economic impact of green loans and improving green credit incentives for commercial banks (Esgandari et al., 2022). Some economists believe that green credit can improve financial performance, but some economists find that the existing literature examples are very few, mainly involving some listed banks, so the conclusions are unstable and not representative.

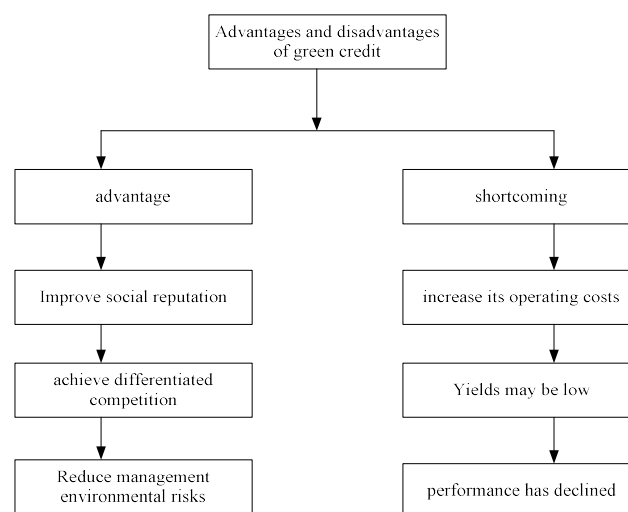


Figure 3. Advantages and disadvantages of green credit.

As shown in **Figure 3**, by increasing the share of green credit in total loans, it is possible to increase the net margin of bank interest rates, suggesting that green loans can help improve banks’ financial performance. Especially among large banks, there

is no significant difference between banks holding different securities, which may encourage commercial banks to adopt more green loans. By increasing the proportion of green credit, banks can invest in environmental protection and sustainable development and attract more customers related to these fields. This will not only help improve the image and reputation of banks, but also contribute to the goal of sustainable finance. In addition, as green loans are often linked to environmental projects, banks may enjoy lower risks in debt repayment, thus boosting their net profits. Therefore, increasing the proportion of green loans in a bank's loan portfolio will have a positive impact on the bank's financial position and performance.

2.3.2. Green credit affecting ESG indicators

Social responsibility for the environment increases resource constraints, so banks invest resources and labor in other economic activities, which negatively impacts the bank's financial performance. Green loans can improve and weaken banks' financial performance. Developing new business areas and improving environmental risk management capabilities can improve financial performance, increase costs and losses to customers, and reduce financial performance (Gallas et al., 2020; Hassan et al., 2018; Lee et al., 2018). Green credit helps commercial banks build a good image and improve their own characteristics. From a commercial point of view, the development of green credit encourages commercial banks to take advantage of the opportunities of green industry development to increase the popularity of green credit brands. Implement high-quality green projects to improve the profitability of green loans. In terms of incentive policies, ESG includes fiscal and tax policies such as subsidies, interest discounts, tax reductions and exemptions, as well as regulatory policies to enhance the attractiveness of green credit and green bonds. Guide long-term funds with certain social attributes, such as pensions, insurance, and social security, to enter the ESG investment market, and incorporate them into the evaluation system to enrich the sources of funds in the green credit market.

At the level of corporate governance, internal competition plays a positive role in improving corporate performance. Through the competitive process, the principle of survival of the fittest is applied, which helps to promote the continuous development within the company and motivate the employees. The existence of internal competition encourages employees to constantly pursue excellence and strive to achieve outstanding performance in the company. This competitive culture encourages employees to actively compete with each other and constantly improve their abilities and performance, thus pushing the entire company toward higher goals. Through internal competition, the company can find and cultivate talents with potential and reserve talent resources for the development of the enterprise. At the same time, competition can also stimulate employees' innovative thinking and creativity, and promote the company to constantly innovate, improve and innovate to adapt to the changes of the market and the pressure of competition. Therefore, internal competition is an important aspect of corporate governance, which helps to promote the development of the company and enhance its competitiveness and vitality.

Second, building a positive corporate image is crucial. This will help to improve the public's perception of the company, especially in shaping an environmentally friendly image. This image can greatly enhance a company's commercial competitiveness and gain the support of national regulators, financial institutions and public authorities. For example, lowering interest rates on certain bank projects and promoting green loans are effective. This will not only reduce the consumption of natural resources by businesses, but also improve environmental sustainability and meet the public's demand for sustainable development. At the same time, companies can further establish a good public image and win consumer recognition and support by implementing environmental initiatives, such as reducing carbon emissions and promoting renewable energy. Such efforts not only contribute to the development of enterprises, but also contribute to the sustainable development of society and the environment.

Third, reducing environmental risks is critical to a company's financial position and may increase its legal and financial losses. One of the important environmental risks is credit risk. If the company fails to meet the exemption parameters, it will face penalties such as suspending operations, repairing environmental damage and paying compensation. Therefore, companies need to take corresponding measures to reduce environmental risks. Secondly, risk insurance is also crucial. The company shall regularly monitor and identify environmental information, including during and after the occurrence of environmental pollution. In this way, companies are still able to provide loans to investors and can independently develop green industries with the main objectives of protecting the environment, controlling environmental risks and improving asset quality. By reducing environmental risks, companies are able to protect their financial position and avoid possible legal and financial losses. In addition, risk insurance can provide companies with additional assurance that appropriate measures can be taken when environmental problems arise. In this way, the company can continue to provide loans to investors and actively develop green industries to achieve both environmental protection and asset quality.

2.3.3. Future focus and significance of green development

Under the leadership of the former China Banking Association Supervision Committee, China Banking Regulatory Commission issued the "China Banking Industry Implementing Green Bank Evaluation (Trial) Plan" (Yang and Shaqfeh, 2018). China Banking Union organized a green bank assessment team to conduct assessments and reviews, submit the preliminary results of the assessment, and submit the review and conclusions of the Green Bank Rating Expert Panel. The publication of the operating plan indicates that the assessment exercise for the Chinese green bank has begun. Common criteria have been developed for assessing green financing practices, resources and progress across different banks. The first assessment of green banks should take place this year. The "Guideline for the Green Financial System" issued by seven ministerial-level committees clearly stated, "We will promote the establishment of self-regulatory institutions in the banking industry and gradually establish an environmental protection assessment mechanism for the banking industry". The green bank assessment plan announced this time represents the specific implementation of the policy. According to the guideline, the operating

plan should specify the development of evaluation indicators, the organizational process of evaluation work, and the rational use of evaluation results. The assessment scope of green banks will be gradually expanded to small and medium commercial banks. The evaluation of green banks will help promote the healthy and sustainable development of green loans in China's banking industry. Green bank valuation is an important benchmark for local governments to evaluate local green banks, and bank loans still account for the majority of social funds in China. Therefore, it is particularly important to mobilize the Chinese banking industry to develop green loans. As an important part of China's green loan, green loan is the oldest, largest and most mature part of China's green loan. Regulatory and administrative departments have established a green credit policy system based on a green credit statistical system and evaluation mechanism. Effectively regulate the green credit development of Chinese banking institutions. In the absence of an effective mechanism to stimulate, and limit the motivation and enthusiasm of banks for green lending, this is still not enough, and only banks that see green lending as an important sector will attract attention. Through the green bank evaluation mechanism, the implementation of the green bank evaluation plan can provide effective incentives for banks to issue green loans, manage financial institutions, actively participate in environmental finance, do a good job in environmental risk management, and improve environmental performance. Effectively promote the healthy and stable development of green loans in China's banking industry. Banks' green loans are one of the biggest concerns. Many countries have established mechanisms to limit and support green lending. Banks are required to report annual progress in green lending and green lending. Conduct environmental assessments of local banking institutions and make rational use of the assessment results. In the case of assessment methods, local regulators and administrators can develop assessment methods for local green banks, as well as local green credit and banking conditions. The annual results of green bank assessments, as well as some local incentive policies such as interest rate repayment, appropriate financial deposit incentives, and risk sharing, can effectively and appropriately implement the assessment results to promote the sustainability of local green loans (Czech and Roberts-Sklar, 2017).

3. Empirical research

3.1. Variables and data

In 2012, the Green Credit Guideline was issued by china banking regulatory commission, which officially included the support of energy conservation, emission reduction and environmental protection of banking financial institutions into the framework of performance evaluation, indicating that the environmental impact of bank credit has become a part of business performance. The Green Credit Statistical System promulgated in 2013 clearly defined the scope of green credit projects of banks for the first time, and was one of the first attempts to define green loans in emerging markets. The "Key Evaluation Indicators of Green Credit Guideline" was released in 2014. Qualitative indicators focus on organizational management, policy system, capacity building, process management, internal control management, information disclosure, supervision and inspection. In order to ensure the consistent

observation interval before and after the implementation of the green credit policy, we took the period from 2010 to 2020 as the pilot period of the Green Credit Guideline, and the A-share listed companies in Shanghai and Shenzhen were used as the research samples. The data were processed as follows: 1) samples with missing ESG and control variables were removed; 2) eliminate the companies that are receding from the stock market after the introduction of policies; 3) remove ST (Special Treatment) company samples. After the above screening, a total of 27,338 annual observations were obtained. Among them, corporate ESG performance data were obtained from the database of the Huazheng ESG Rating, and corporate finance and corporate governance related data were obtained from the CSMAR (China Stock Market & Accounting Research) database. **Table 1** reports the specific definition of all variables.

Table 1. Variable definition.

Type	Symbol	Variable	Description
Explained variable	ESG	ESG ratings	ESG scores from 1 to 9
	EERE	Green industry	Green enterprise=1, Else=0
Grouping variables	POLLUT	Polluting industry	Pollution enterprise=1, Else=0
	POST	Policy year	After 2014=1, Else=0
Control variable	SIZE	Firm size	The natural log of total assets
	Lev	Debt to asset ratio	Corporate liabilities / total assets
	ROA	Return on total assets	Net Profit/total Asset
	Cashflow	cash-to-total assets ratio	net cash flow for the current period / total assets at the end of the year
	FIXED	Fixed assets	Fixed assets / Total assets
	INDEP	Board independence	Number of independent directors / Board of Directors
	BM	Book-to-market ratio	Shareholders' equity / Company market capitalization
	FIRMAGE	Enterprise age	The natural log of enterprise age

3.2. Research model

This paper takes the release of “Key Evaluation Indicators of Green Credit Guideline” in 2014 as the impact event, adopting the data of A-share listed companies in Shanghai and Shenzhen from 2010 to 2020 to construct a difference-in-difference (DID) model as shown below.

$$ESG_{it} = \beta_0 + \beta_1 TREAT_i \times POST_t + \sum Control_{it} + \varepsilon_{it} \quad (1)$$

The explained variable ESG_{it} represents the ESG performance of i listed company in year t ; Core explanatory variable $TREAT_i$ indicates whether the industry to which enterprise i belongs is a green or polluting industry. If it is a green or polluting industry, the value is 1; otherwise, the value is 0. $POST_t$ is a dummy variable implemented in 2014. When t is greater than or equal to 2014, the value is 1; otherwise, the value is 0. Control is a set of control variables that affect a company's ESG performance. ε_{it} is the random error term of the model. The coefficient β_i

before the interaction term $TREAT \times POST$ is the value we mainly focus on, which significantly represents the significant impact of policy implementation.

3.3. Parallel trend test

The key to effectively identify the impact of “Key Evaluation Indicators of Green Credit Implementation” and ESG by using DID model is that the treatment group and the control group satisfy the parallel trend hypothesis before the policy implementation. Therefore, the parallel trend test was first conducted in this paper, as shown in **Figure 4** and **5**. In the years before the policy implementation (2014), the 95% confidence interval not contained 0, indicating that there was no significant difference between the treatment group and the control group before the policy implementation, satisfying the parallel trend hypothesis.

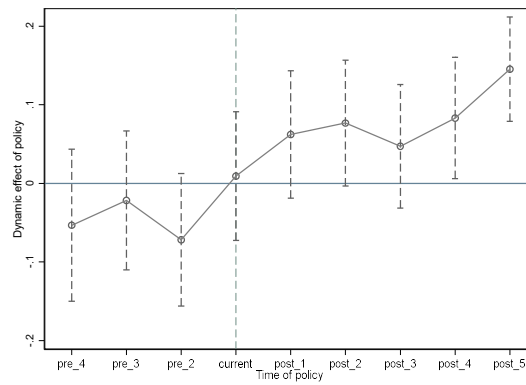


Figure 4. Parallel trend test (Green industry).

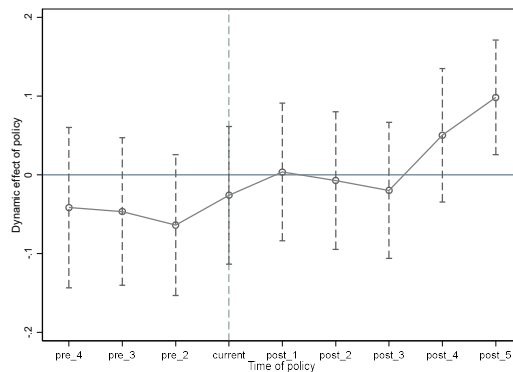


Figure 5. Parallel trend test (Polluting industry).

3.4. PSM-DID

We conducted an empirical test on the relationship between green credit policy and ESG under the group of green and polluting enterprises, as shown in **Table 2**. The complete regression results of columns (1) and (2) show that the interaction terms $_diff$ are 0.162 and 0.113, respectively, that is, the estimated coefficients of $TREAT \times POST$ are significantly positive at the level of 1%, and green credit policies have a positive effect on the ESG performance of green and polluting enterprises.

In addition, we used the propensity score matching DID model (PSM-DID) to mitigate the endogeneity issues, reduce sample selection bias, and ensure

comparability between treatment and control groups. Based on the experience of Latorre et al. (2018), Wang et al. (2019), Jin et al. (2021), we select all control variables as covariables for nearest neighbor matching. Columns (3) and (4) in **Table 2** show the results of PSM-DID regression. The estimated coefficients of the interaction term of *_diff* of green and polluting enterprises are 0.150 and 0.086 respectively, which are significantly positive at the level of 1% and 10%. The regression results are basically consistent with the main regression, which further supports the benchmark regression results.

Table 2. DID & PSM-DID results.

	DID		PSM-DID	
	(1)	(2)	(1)	(2)
	EERE	POLLUT	EERE	POLLUT
TREAT	-0.180*** (0.028)	-0.202*** (0.029)	-0.177*** (0.034)	-0.197*** (0.038)
POST	-0.281*** (0.019)	-0.262*** (0.018)	-0.297*** (0.029)	-0.264*** (0.033)
<i>diff</i>	0.162*** (0.032)	0.113*** (0.034)	0.150*** (0.039)	0.086* (0.044)
Size	0.345*** (0.007)	0.343*** (0.007)	0.332*** (0.010)	0.329*** (0.011)
Lev	-0.538*** (0.041)	-0.532*** (0.041)	-0.600*** (0.057)	-0.587*** (0.064)
ROA	1.955*** (0.117)	1.977*** (0.117)	1.498*** (0.161)	1.369*** (0.187)
Cashflow	0.017 (0.106)	0.004 (0.106)	0.003 (0.146)	0.100 (0.170)
FIXED	-0.178*** (0.044)	-0.107** (0.045)	-0.226*** (0.056)	0.022 (0.063)
Indep	-0.119 (0.120)	-0.120 (0.120)	-0.158 (0.164)	0.013 (0.186)
BM	0.013* (0.008)	0.015** (0.008)	0.017 (0.012)	0.011 (0.013)
FirmAge	0.078*** (0.021)	0.083*** (0.021)	0.098*** (0.029)	0.100*** (0.033)
<i>_cons</i>	-0.951*** (0.165)	-0.937*** (0.165)	-0.633*** (0.223)	-0.722*** (0.252)
N	27338	27338	15029	11641
adj. <i>R</i> ²	0.146	0.146	0.131	0.132

Notes: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.5. QDID and kernel

Quantile DID (QDID) is a regression method combining quantile regression model and different-difference model (Athey and Imbens, 2006). QDID combines

the advantages of quantile regression. When conducting policy assessment, it is not easy to be affected by extreme values, but also can analyze the degree of influence of policies on explained variables at each sub-point, so as to conduct a more reasonable and comprehensive analysis of policy effects.

Columns (1) and (2) in **Table 3** show the regression results of the influence of green credit policy on ESG of green and polluting enterprises after QDID regression with point 0.5. Columns (1) and (2) show that the regression coefficients of the interaction term *_diff* of green and polluting enterprises are 0.161 and 0.144 respectively, which is significantly positive at the 1% level, indicating that the policy has a positive effect on the ESG of green and polluting enterprises. The result of regression is basically consistent with that of main regression, which further supports the result of baseline regression.

Based on the studies of Villa (2016) and Chen et al. (2022), we also introduce kernel regression to test robustness, as shown in **Table 3** columns (3) and (4). The regression coefficients of the interaction term *_diff* of green and polluting enterprises are 0.100 and 0.084 respectively, which are significantly positive at the level of 1% and 5%, indicating that the policy has a positive effect on the ESG of green and polluting enterprises. The result of regression is basically consistent with that of main regression, which further supports the result of baseline regression.

Table 3. QDID and kernel results.

	QDID		Kernel	
	(1)	(2)	(3)	(4)
	EERE	POLLUT	EERE	POLLUT
TREAT	-0.177*** (0.028)	-0.228*** (0.029)	-0.129*** (0.027)	-0.176*** (0.027)
POST	-0.214*** (0.019)	-0.203*** (0.018)	-0.040* (0.023)	-0.032 (0.023)
<i>_diff</i>	0.161*** (0.033)	0.144*** (0.034)	0.100*** (0.033)	0.084** (0.033)
cons	-1.751*** (0.169)	-1.710*** (0.165)	6.594*** (0.019)	6.591*** (0.019)
Control	Yes	Yes	Yes	Yes
N	27338	27338	22501	22439
adj. <i>R</i> ²	0.053	0.054	0.001	0.003

Notes: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4. Conclusions, implications and limitations

4.1. Conclusions

This paper analyzed the relationship between green credit and ESG performance, it is found that investors will have better benefits, and companies will have a broader space for development than companies. Based on the fact that the article is not enough, it is necessary to count the investment income level of different investors, and the return rate of each investor is not clear. Our empirical research

indicates the implementation of “Key Evaluation Indicators of Green Credit Guideline” has a positive impact on ESG performance of both green and polluting firms in comparison with others. The result was fully supported by different methods and models, including PSM-DID, QDID, and Kernel regression, providing more implications and references for policy makers. In conclusion, by integrating ESG issues with business decisions, companies can reduce risk, enhance social image, and achieve sustainable development goals. Governments, enterprises, investors and the public should work together to strengthen governance of environmental issues and promote the wide application of ESG principles in business activities, so as to contribute to sustainable development in harmony with economic prosperity, social progress and environmental protection.

4.2. Discussions

Regulatory and evaluation mechanisms need to be strengthened, where the effective implementation of green credit policy requires the establishment of sound supervision and evaluation mechanism. The government and regulators should closely monitor the implementation effect of green credit policies and timely adjust effective measures to maximize the development of green finance and the improvement of ESG performance. In addition, establishing more scientific, objective and reliable evaluation indicators and methods to evaluating and monitoring the green and sustainable performance of enterprises is conducive for improving the accuracy and effectiveness of green policies. Further, the implementation of green credit policies requires companies to provide relevant environmental, social and corporate governance information. By requiring enterprises to disclose relevant data and information, the government and financial institutions can strengthen the supervision and management of enterprises and improve the transparency of information, so as to enhance the implementation effect of policies and enterprises’ awareness of responsibility. Meanwhile, the government and financial institutions can strengthen cooperation and establish a linkage mechanism for green credit policies. Through concerted action, governments and financial institutions can jointly develop green finance standards and guidelines, enhance information sharing, and improve financial institutions’ ability to assess the risk of green projects and enterprises, so as to better support the development of green finance and the improvement of enterprises’ ESG performance. In addition, governments can use economic incentives such as tax breaks, incentives and subsidies to guide companies to adopt environmentally friendly and sustainable behaviors. These incentives can help enterprises reduce the cost of green transformation, increase the demand for green finance, and further promote the improvement of enterprises’ ESG performance. Finally, policy makers should pay close attention to the trend and experience of international green finance development, learn from advanced international experience, and constantly improve green credit policies. Through cooperation and exchange with other countries and international organizations, the government can accelerate the development of green finance, improve the international competitiveness of Chinese enterprises and contribute to the realization of sustainable development goals.

Our results show green credit policies play a positive role in promoting the improvement of enterprises' ESG performance and promoting green transformation. Policymakers should further strengthen policy supervision, improve information transparency, while increasing support for green finance and sustainable development. In addition, policymakers can also actively guide financial institutions and enterprises to carry out green finance innovation and provide more financial products and services that meet environmental protection and sustainable standards, so as to meet market demand and promote the development of green economy. The government should strengthen the implementation and supervision of green credit policies to promote the environmentally friendly transformation of enterprises. In addition, policymakers should focus on developing scientifically feasible policy evaluation frameworks, combining multiple research methods and models to verify policy effects, and constantly improving and optimizing policy measures. The development of green credit will become the focus of the banking industry in the future, and has important significance. The development of green credit not only promotes the overall stability and sustainability of the financial system, but also attracts more investors and funds into the green economy sector. By directing funds to environmental protection and low-carbon sectors, green credit can help balance the relationship between the economy, society and environment on promoting economic transformation and sustainable growth. It supports innovation and technological progress, promotes the development and application of clean energy, reduces dependence on traditional high-polluting industries, and improves the resilience and competitiveness of the entire economy. By providing green credit products and services, financial institutions can meet investors' demand for sustainable investment, attracting more funds to green projects and enterprises. This not only helps to promote the application of green technology and innovation, but also provides enterprises with financial support for sustainable development and promotes the synergistic development of economy and environment. Furthermore, only by working together to integrate ESG indicators into our daily operations can we achieve our goals of economic prosperity, social progress and ecological balance. Meanwhile, education and public awareness are also key factors in promoting the integration of environmental governance and ESG principles into business decision-making. Through education and publicity, public awareness of the importance of environmental protection can be increased, people can pay more attention to environmental issues and support those enterprises that take positive environmental actions.

4.3. Limitations and future directions

The interpretation and application of the research results need to be cautious, because the study only uses data of A-share listed companies, which limits the universality and generalization of the results, and there may be different situations of other types of enterprises or regions. Although various econometric methods are used to solve the endogeneity problem, there may still be missing variables that are not considered to affect the results, such as other policy measures, market factors or firm characteristics and other factors that may have an impact on the results of the study. Although DID, PSM-DID, QDID and other methods were adopted in this

study to evaluate the impact of green credit policies on corporate ESG performance, there are still limitations of causal inference. Other unaccounted factors or reverse causality may have influenced the results, so the results need to be interpreted with caution. In addition, propensity score matching was used to improve the comparability between the treatment group and the control group, but there may still be selection bias. The selection criteria and matching algorithms for the treatment and control groups may affect the results of the study, so further verification and confirmation of comparability are needed. The research time range is from 2010 to 2020, but the policy implementation may take longer to fully emerge, and there may be some lag effect, so the research results cannot fully reflect the long-term impact of the policy. Finally, the results are mainly based on the context and implementation of green credit policies in China, so its external effectiveness may be affected by differences in other countries and regions. The effects of specific circumstances and policy differences need to be considered when applying the findings to other areas. In conclusion, the implementation of green credit policy has a positive impact on the ESG performance of green and polluting enterprises. However, further research and practice still need to be carried out on the basis of considering limitations in order to promote the realization of sustainable development and environmental protection.

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