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Research on Blockchain Technology to Solve the Problem of Green Finance 'Greenwashing': Focusing on the Transparency of ESG Financial Supervision

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Abstract: This paper focuses on the transparency of ESG financial regulation and explores the application path of blockchain technology in solving the "greenwashing" problem of green finance. Blockchain tackles the challenge of greenwashing in green finance through several approaches. First, it enables real-time recording of a project's environmental data on the blockchain, which is then verified by multiple nodes to prevent unilateral alterations. Second, by setting predefined ESG performance thresholds, fund disbursements are automated only when these criteria are met, effectively discouraging misleading pledges. Third, the blockchain ensures full traceability of data throughout the project lifecycle, from initiation to operation, with the added support of IoT devices to guarantee data integrity. Lastly, the involvement of entities such as regulators and independent auditors in maintaining the distributed ledger helps bridge information gaps, making any attempt at greenwashing easily detectable and unfeasible. By integrating domestic and foreign academic literature and policy reports, this paper analyzes the causes of the "greenwashing" phenomenon and the limitations of traditional governance, the characteristics and advantages of blockchain technology, reveals the core advantages of blockchain technology applied to green finance and its important role in realizing data trust sharing, capital flow monitoring and dynamic supervision, and explores and puts forward countermeasures and suggestions for the challenges faced by technology application. In order to improve the efficiency of green finance regulation and promote the sustainable development of the industry, this paper provides theoretical and practical reference. This study seeks to offer robust theoretical foundations and practical guidance to improve the efficiency of green finance regulation and support the sustainable growth of the sector.

Keywords: Green Finance; Greenwashing; ESG; Financial Regulation; Transparency

1. Introduction

Green finance aims to guide the flow of funds to environmentally friendly, low-carbon and sustainable projects and industries through the effective allocation of financial resources, so as to help realize the synergy between economic growth and environmental protection. Driven by the global climate crisis and the Sustainable Development Goals, green finance, as a core tool to achieve green economic transformation, is expanding at an unprecedented rate.

However, with the rapid development of green finance, the problem of "greenwashing" has become increasingly prominent. Some enterprises and financial institutions cheat policy support and investment by exaggerating and fabricating green projects, resulting in misallocation of funds, seriously weakening the role of green finance in supporting the real economy, and damaging the interests of investors and market confidence. The "greenwashing" behavior of enterprises hinders the healthy development of green finance, because it is likely to lead to adverse selection, so that real green innovation cannot be supported, and green funds will be difficult to flow to clean industries [1].

The concept of ESG is highly consistent with China's "dual carbon" goal. In the context of ecological civilization construction, more and more companies choose to publicly disclose ESG reports, and the improvement of quantity is transformed to the improvement of quality, which increases the credibility of information and helps enterprises reduce pollution and improve positive externalities (Liu and Lu, 2024). [2] Compared with financial statement information disclosure, as non-financial information, ESG information has not yet been proposed as a complete and proven effective ESG rating system in China [3], which leads to non-standard disclosure of ESG

information by companies, and ESG greenwashing becomes a speculative behavior with low cost and a good public image in the short term [4]. However, within the realm of green finance, greenwashing describes a deceptive practice where organizations or initiatives exploit the concept of "green" to conceal actual environmental damage, primarily driven by profit motives. This phenomenon typically appears in several forms: misrepresenting projects as environmentally friendly, such as presenting highly polluting factories as eco-parks; overstating ecological benefits, like advertising "zero emissions" despite failing to meet pollution control standards; and misusing green certifications, for instance labeling regular bonds as "green" to attract sustainable investment. Such practices threaten fair competition and obstruct the advancement of genuine sustainability goals. However, the traditional supervision mode relies on manual verification, which has defects such as information lag, lack of inter-agency coordination, and difficulty in supervision traceability. Therefore, technological innovation is urgently needed to solve the dilemma.

With the development of science and technology, some scholars have noticed the potential of blockchain in green finance. Studies have pointed out that blockchain technology, as a decentralized ledger, has tamper-resistant characteristics and can effectively solve problems such as investment risks and monitoring difficulties caused by information asymmetry in green finance [5]. The improvement of information transparency can help relevant institutions to effectively monitor and verify the process of green finance, and effectively reduce the risk of "greenwashing" [6]. Therefore, this paper aims to review the systemic issues of the application of blockchain technology in ESG anti-greenwashing and regulatory transparency, as well as how to promote the construction of a credible and transparent ESG ecosystem.

2. Challenges of ESG Greenwashing and Regulatory Transparency: Current Status and Limitations

Mandatory part of the world's stock exchange listed companies to disclose ESG related information, but the vast majority of stock exchanges is still taking the form of voluntary disclosure. China does not yet have a complete ESG disclosure standard framework, and ESG information disclosure of enterprises is more spontaneous [7]. As ESG performance has gradually become an important consideration of enterprise value, many enterprises hope to gain the favor of the capital market by releasing the signal of their good ESG performance to the outside world. Corporate disclosure of ESG information to the capital market, comprehensive introduction to enterprise in the environmental, social responsibility and corporate governance performance, help enterprises to establish a good reputation and get more external support [8]. From the angle of the government, although there are more and more companies taking the initiative to disclose information on ESG, the corporate disclosure quality is uneven. At present, the ESG reports of most Chinese enterprises have not been examined, and the credibility has yet to be verified [7]. In recent years, ESG information disclosure mode has experienced a paradigm shift from voluntary to compulsory. Compared with the completely voluntary disclosure, which is easy to misunderstand ESG as a free moral responsibility and investment preference, the mandatory disclosure more highlights the current strategic position of ESG in sustainable development and green governance [9]. However, the mandatory information disclosure model also has certain limitations. 1) Mandatory information disclosure may generate high information disclosure costs, which in turn prompts enterprises to have passive ESG information disclosure greenwashing behaviors in order to formally meet policy requirements [9]. 2) Although mandatory ESG information disclosure needs to clarify the subject and content of disclosure, its inherent lag and rigidity lead to the relatively single and limited information disclosed, which is difficult to meet the diversified and decentralized information needs in the multi-level capital market. 3) According to the data, mandatory ESG information disclosure can improve the availability of ESG reports [10]. However, its authenticity depends on a mature investment environment and a perfect institutional system as a guarantee. At present, China's ESG environment is not sufficient to support mandatory ESG information disclosure [9].

To sum up, the reason why the current governance mechanism of ESG information disclosure is difficult to fundamentally solve the problem of greenwashing lies in the intertwined influence of multiple structural defects. The main reasons are insufficient credibility, asymmetric information and lack of real-time supervision, and many other aspects.

3. Blockchain Technology as a Solution: Mechanisms and Applications

Studies have pointed out that blockchain technology, as a decentralized ledger, has tamper-resistant characteristics and can effectively solve problems such as investment risks and difficult monitoring caused by information asymmetry in green finance [11]. Improving information transparency helps relevant institutions to effectively supervise and verify the green finance process, thus significantly reducing the risk of "greenwashing" behavior. Therefore, in order to further promote the development of green finance, we should make full use of blockchain technology, improve the mechanism of green project disclosure, improve the efficiency of green finance project cooperation [12]. Thus, academia has been in the chain of blocks technology used in green finance area has carried out many studies. However, the existing achievements mainly focus on the application level optimization and mechanism design, and most of them are based on the traditional blockchain technology. There is still a lack of in-depth discussion on the theoretical basis of the "greenwashing" phenomenon, and how blockchain can cooperate with other fintech means to prevent "greenwashing" and promote the development of green finance.

At the same time, blockchain is an immutable distributed ledger [13], which is widely used in various fields to break the phenomenon of "information island". In the field of green finance, blockchain technology helps to build an efficient reputation management system by virtue of its immutable information, thus increasing the reputation cost of enterprises to obtain green loans through false means. At the same time, the application of smart contracts can effectively reduce operational risks, promote business process automation, accurately control the flow of funds, and ensure that green funds effectively support green innovation activities. However, blockchain technology also has a crucial problem -- it cannot guarantee the quality of on-chain information [14]. Therefore, with the continuous progress of blockchain technology, its integration and innovation with artificial intelligence, Internet of Things and other technologies is gradually becoming the key research direction of academic attention. The combination of blockchain technology with the Internet of Things and satellite remote sensing can realize the full automation of data collection and acquisition, which not only enhances the authenticity and reliability of information, but also expands the way of data acquisition and supports the cross-validation of multi-source information, so as to achieve all-round and penetrating dynamic monitoring. In addition, the combination of blockchain and artificial intelligence can combine the data distribution of blockchain with the data concentration of artificial intelligence, which can well simulate the way people capture and process data, thus reducing the difficulty of identification and authentication of green innovation, and increasing the possibility of discovering the "greenwashing" behavior of enterprises [15]. Its core is to enhance information transparency, reduce the information asymmetry phenomenon, thus increase the difficulty of the implementation of "green" behavior and cost, so as to curb "green" enterprises.

In addition, blockchain technology can tokenize and digitize traditional green assets, and further split these tokenized green assets into green rights and interests based on core enterprises. The value and transaction information of these green assets are recorded on the blockchain, which ensures the public verifiability of the transaction process and results, thus realizing the security, transparency and decentralization characteristics of green token transactions. Through this splitting mechanism, the credit of core enterprises can be transmitted step by step throughout the supply chain, covering secondary and even multi-level suppliers and dealers, and also helping to achieve the accuracy of rights confirmation. With the help of the credit endorsement and the ownership of green assets, financial institutions can be guided to effectively allocate financial resources to those small and medium-sized enterprises at the end of the supply chain that also have green capital needs, reduce the credit risks faced by financial institutions, and thus improve the efficiency of resource allocation in green supply chain finance, and meet the capital needs of the whole supply chain.

4. Build the Framework and Future Prospect of Credible ESG Ecology

From the perspective of principal-agent theory, the "greenwashing" behavior of enterprises is caused by information asymmetry, and according to the existing research, information asymmetry will lead to greater financing constraints for enterprises [16]. When the problem of information asymmetry is alleviated, the agency risk is reduced, so information transparency is a better way to solve

the problem of "greenwashing" [17]. The core value of blockchain to solve greenwashing and improve transparency lies in its decentralized, immutable and traceable characteristics. Decentralized data breaking monopoly, multi-node jointly maintain books, ensure the data source widely and true; Immutable makes the ESG data on the chain cannot be changed at will once it is recorded, enhancing data credibility; Traceability allows the whole process of data flow to leave traces, and can accurately locate the source and flow of data for easy verification. On the theoretical basis, the consensus mechanism of blockchain enables all participants to reach an agreement on data recording and verification, while smart contracts automate the execution of preset rules to ensure that ESG related business processes are promoted according to established standards, fundamentally improving data quality and regulatory transparency.

In the future, a green financial ecosystem will be established through blockchain to promote cooperation and sharing between different institutions and individuals. Blockchain technology can provide a secure, transparent and efficient platform for data and value sharing, so that all parties can cooperate and share green financial resources and information more conveniently [18]. First, it is necessary to cultivate fintech professionals and make full use of big data technology to improve the information acquisition and information analysis capabilities of financial institutions [19]. Second, cross-chain technology should be studied to realize data communication between different platforms, promote the integration of blockchain with the Internet of Things and big data, and improve the efficiency of data collection and processing. Third, the government should provide financial support and further strengthen investment in fintech projects. At present, the application standards of blockchain technology in various industries are still under continuous exploration and improvement. To promote the chain block and the depth of the green financial integration, our country needs to strengthen financial support and channel funds, actively encourage enterprises and institutions of main body participation block chain technology research and development and innovation, to its application in the field of green finance lay a solid foundation. Four is regulatory standards system should be improved, with the aid of colleges and universities, research institutes and other technical forces by making a green financial block chain data standards, building an interagency data exchange mechanism and unified data chain block format and interface specification chain green financial ecosystem. Finally, should be perfect under the rule of law regulatory framework, the application of the scientific guide block chain technology. Currently, in view of the chain block technology, the legal system is not perfect. related system construction relative lag. Therefore, to accelerate establishing and perfecting the supervision mechanism, promote the standardization of the use of blockchain technology and compliance, and to ensure that its application in the field of green finance is both safe and efficient, provide a powerful guarantee for the healthy development of the industry.

5. Conclusion

This study deeply analyzes the potential and challenges of blockchain technology in solving the "greenwashing" problem of green finance and enhancing the transparency of ESG financial regulation. Blockchain technology with its decentralized, tamper-resistant, traceability and other core features, in theory, to solve the ESG drift phenomenon of green provides a revolutionary tool to improve regulatory transparency. It can effectively deal with the pain points of existing mechanisms in terms of data authenticity, information asymmetry and regulatory lag, and shows broad application prospects in scenarios such as green financial product traceability, enterprise ESG information disclosure and carbon trading market supervision. However, the application of blockchain technology in green finance for greenwashing governance faces multidimensional limitations. Technologically, cross-chain interoperability remains challenging, and smart contracts are susceptible to vulnerabilities. Legally, data ownership is ambiguously defined, and cross-border compliance conflicts are prominent. From a regulatory perspective, the anonymity inherent in blockchain increases the difficulty of supervisory oversight, and standardization has yet to be established. In terms of market acceptance, small and medium-sized enterprises resist adoption due to high costs, and investors exhibit insufficient trust in the technology. A multifaceted approach is essential to address these bottlenecks. Although the large-scale application of blockchain in ESG finance still faces major challenges in terms of technology, law, regulation and market acceptance, with policy support and technology iteration,

blockchain is expected to become the core infrastructure for the high-quality development of green finance. In the future, it is necessary to strengthen the industry-university-research collaborative innovation, promote the deep integration of blockchain technology and green finance, and provide technical support for the realization of the "dual carbon" goal.

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