Research on Green Bonds and Suggestions on Development Countermeasures

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***Abstract*—Since the European Investment Bank (EIB) successfully issued the world's first "climate-conscious bond" in 2007, countries worldwide have embarked on the process of issuing green bonds. Many scholars have conducted a series of studies on green bonds and have made important progress. However, few previous studies have systematically analysed the progress of the research on green bonds. Therefore, we first comb through the definitions and connotations of green bonds. Then, we summarise the characteristics of green bonds and their issuance status worldwide and clarify their internal and external drivers. Next, we describe the impacts generated by green bonds, both positive and negative. Finally, we address the current problems in green bond issuances and the problems of previous studies and provide an outlook for the future, pointing out the direction for the progress and development of green bond research.**

***Keywords*—green bonds, research progress, recommendations, finance**

I. Introduction

Since 2008, when the World Bank and Nordea issued the first bond explicitly named after a green bond, green bonds have developed rapidly. In 2009, the Climate Bond Institution (CBI) was established to mobilise the bond market to combat climate change. The year 2014 saw the issuance of the Green Bond Principles (GBP) by the International Capital Market Association (CIMA), which laid the foundation for the standardisation of green bonds. In 2014, the International Capital Market Association (CIMA) released the Green Bond Principles (GBP), which laid the foundation for the standardised development of green bonds. China's green bonds have also been growing rapidly in recent years. In 2015, China's central government issued the Overall Programme for the Reform of the Ecological Civilisation System, which explicitly advocated for the establishment of a green financial system and proposed to "study the issuance of green bonds by banks and enterprises". In 2016, China began issuing green bonds and became the world's largest issuer of green bonds that year. On 22 September 2020, the Chinese leader Xi Jinping proposed at the UN General Assembly that China achieve peak carbon by 2030 and carbon neutrality by 2060 as a "dual carbon" goal. In recent years, many scholars have discussed the topic of green bonds; therefore, discussing the progress of research on green bonds and related development countermeasures is particularly important. However, previous studies have seldom systematically evaluated the progress of research on green bonds. Therefore, we analyze previous scholars' research on green bonds from various perspectives, put forward the shortcomings of the current research and provide an outlook for the future.

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II. Definition and Meaning of Green Bonds

There are currently three main international definitions of green bonds, namely, the definition of green bonds by the European Union Sustainable Classification Programme (EU Taxonomy), the definition of green bonds by the International Capital Market Association (CIMA) in the Green Bond Principles (GBP) and the definition of climate bonds. The EU Taxonomy of the Climate Bond Standard (CBS) published by the Climate Bond Institution (CBI) in June 2019 is an important part of the EU action on sustainability finance programmes. The EU Taxonomy, published in June 2019, is an important part of the EU Sustainable Development Financing Initiative (SDFI) initiative, which aims to provide policymakers, industry and investors with clarity on the bonds that are environmentally sustainable and to help capital markets identify investment opportunities that contribute to the achievement of environmental policy objectives. The EU further enacted the Classification Act and the EU Sustainable Finance Classification Climate Authorisation Act to provide legal support and safeguards for the practical implementation of the EU Taxonomy. Green Bonds are defined in the GBP as any type of bond instrument in which the funds raised are used exclusively to partially or fully finance or refinance new or existing qualifying green projects. The GBP contains four core elements, namely, the use of the funds raised, the project evaluation and selection process, the management of the funds raised, and the reporting of the funds raised. The GBP considers that only bonds that strictly comply with these four core elements are considered green bonds. The GBP notes that only bonds

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that strictly comply with the four core elements are green bonds. The investment in funds generated by green bonds covers eight areas, namely, renewable energy, low-carbon industry, low-carbon transport, pollution control, climate change mitigation and adaptation, combating natural resource depletion, and biodiversity conservation. The CBI standard complements the GBP by defining what is considered "green" at the industry level through specific implementation guidelines. The CBI standard identifies eligible projects in eight categories: energy, transport, water, buildings, land use and marine resources, industry, waste disposal, and information and communications technology. Many countries have elaborated on the criteria, with China doing a particularly good job. On 27 April 2021, the People's Bank of China (PBOC), the Development and Reform Commission (DRC) and the Securities and Futures Commission (SFC) jointly issued the Green Bonds.

The notice of the "Catalogue of Supported Projects" has developed a unified provision for green bond standards in China. According to the definition in the notice, green bonds refer to marketable securities, including but not limited to green financial bonds, green corporate bonds, green corporate bonds, green debt financing instruments and green asset-backed securities, that are issued in accordance with legal procedures and that repay the principal and interest according to the agreement by dedicating the funds raised to support green industries, green projects or green economic activities in compliance with the prescribed conditions. Eligible green projects are specifically defined, and the projects cover a wide range of fields, such as the energy-saving and environmental protection industry, clean production industry, clean energy industry, ecological environment industry, infrastructure upgrading and green services (Table I).

TABLE I. CATALOGUE OF PROJECTS SUPPORTED BY GREEN BONDS

First Level Catalogue	Secondary Catalogue	Tertiary Catalogue
Energy saving and environmental protection industry	Energy Efficiency Improvement	Energy-efficient equipment manufacturing, industrial energy-saving reform
		Energy conservation in manufacturing and power consumption facilities
	Sustainable construction	Green building materials
	Pollution prevention and control	Advanced environmental protection equipment manufacturing, water pollution control,
		Air pollution control, soil pollution control and
		Other pollution control, Comprehensive Agricultural and Rural Environmental Management
		Grain (of wood)
	Water conservation and nonconventional water use	Nonconventional water use
	Comprehensive use of resources	Resource recycling equipment manufacturing, solid waste
		Comprehensive utilisation of biomass, biomass resources comprehensive utilisation
	Green transport	New energy vehicles and green shipbuilding
Cleaner production industry	Pollution prevention and control	Air pollution control of production process
		Water pollution control, industrial park pollution control
		Substitution of nontoxic and nonhazardous raw materials and hazardous waste management
		Grain (of wood)
	Green agriculture	Comprehensive agricultural and rural environmental management
	Comprehensive use of resources	Comprehensive use of solid waste, industrial park resources
		Comprehensive use of resources
	Water conservation and nonconventional water use	Industrial water conservation
Clean energy industry	Energy efficiency improvement	Energy efficiency in electric utilities
	Clean energy	New and clean energy equipment manufacturing, renewable energy
		Construction and operation of bioenergy facilities, clean energy
		Efficient operation
Ecological industry	Green agriculture	Agricultural resource conservation, integrated agricultural and rural environment
		Governance, green agricultural supply
	Ecological protection and construction	Natural ecosystem protection and restoration, ecological production supply
Green upgrading of infrastructure	Energy efficiency improvement	Energy conservation in urban electric power facilities and energy-using facilities
	Sustainable construction	Building energy efficiency and green buildings
	Pollution prevention and control	Urban environmental infrastructure
	Water conservation and nonconventional water use	Water conservation, sponge cities
	Green transport	Public passenger and freight transport in urban and rural areas, railway transport
		Water and air transport, clean energy vehicle distribution
		Suite of facilities
Green services consultancy services	Ecological protection and construction	Urban ecological protection and construction
	Green consultancy technical services	Green operation management services
	Operation management services	Environmental rights, Trading services

	Project evaluation audit verification services	Project evaluation audit verification services
	Monitoring and testing services	Monitoring and testing services
	Technical product certification and promotion	Technical product certification and promotion services

Related scholars have also discussed the definition and connotation of green bonds. For example, Wan (2016) argued that green bonds are bond products that directly or indirectly finance climate and environmentally sustainable development projects and programmes. According to Ba *et al.* (2019), green bonds are debt financing instruments in which the government and relevant departments, financial institutions or nonfinancial enterprises raise funds from society to finance green projects that comply with the regulations and the refinancing of these projects. Moreover, green bonds promise to repay the principal and pay interest as agreed on.

III. Characteristics of Green Bonds and Global Issuance Status

A. Characteristics of Green Bonds

As an important financing tool in the green financial market, green bonds have more advantages than nongreen bonds in terms of cost, efficiency, financial structure and the use of funds raised. Specifically, embodied in the following aspects, 1) compared to ordinary bonds, green bonds must be used for green industry projects for a longer period and with a dedicated purpose; 2) for most of the green bonds issued on the market, there are medium- to long-term financing bonds, mainly because certain green industry project investments need more time to generate returns; generally, the duration of green bonds usually covers the entire construction and operation period, which also leads to the problem of a relative lack of liquidity in the primary and secondary markets; 3) for information disclosure, in addition to disclosing conventional nongreen bonds, disclosing the use of fundraising, authentication reports and auditing reports on a regular basis is also necessary, and disclosure requirements are relatively high; and 4) in terms of policy support, due to the positive externalities brought about by green projects, it is easier for green projects to obtain policy support from government agencies; moreover, obtaining preferential conditions for green bond issuance is also easier.

B. Status of Green Bond Issuance Globally (Types of Green Bonds, Issuers)

1) Types of green bonds

In 2015, the World Bank subdivided green bonds into four major categories, namely, green project bonds, green revenue bonds, green purpose bonds and green securitised bonds, as shown in Table II. Green bonds can be divided into green financial bonds, green corporate bonds, green corporate bonds, green bond financing tools for nonfinancial enterprises, and green structured financing tools according to the different applications of the raised funds in the construction of green industry projects (Xiao, 2017). The details are introduced as follows:

(1) Green financial bonds: the main body of the performance of financial institutions in accordance with the relevant provisions of the State to raise and issue funds to the outside world; such funds are mainly concentrated in the green industry, requiring regular repayment of principal and interest.

(2) Green corporate bonds: bonds that raise funds and apply them to projects in various areas, such as energy conservation and emissions reductions, ecological protection, and the promotion of green urbanisation.

(3) Green corporate bonds: issued mainly through stock exchanges, the funds raised are used in the green industry to promote green development.

(4) Green bond financing tools for nonfinancial enterprises and green structured financing tools include a green project medium-income asset support scheme and green industry credit asset securitisation (Table II).

TABLE II. Classification of Green Bonds

Types of bonds	Purpose of funds	Debt resource
Green project Bonds	Designated green projects	With the assets and income of designated project as collateral
Green Purpose Bonds	Green Mark Project	Secured by the issuer's cash flow
Green Revenue Bonds	Green Mark Project	Secured by cash flows from the issuer
Green Securitised Bonds	Green Mark Project, Designated Green Projects catalogue	With a series of green project assets or underlying loans

2)Green bond issuance

a)Initial development phase (2007–2013)

Since the European Investment Bank successfully issued the world's first "climate-conscious bond" in 2007, countries worldwide have embarked on a process of issuing green bonds, with the World Bank issuing the first green bond in 2008 in conjunction with Sweden's Sveriges Riksbank (SEB). Fig. 1 shows the status of green bond issuance since the first green bond up to 2012.

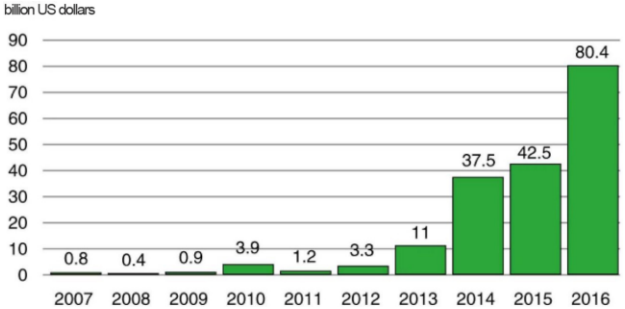

Fig. 1. Green bond issuance, 2007–2016.

b) Rapid development phase (2013 onwards)

After an initial development phase, green bonds entered a phase of rapid growth in 2013, when they began to explode (See chart). Since 2007, green bond issuance has reached $36,593 million, which together has accounted for 80% of the total green bond issuance.

As shown in Fig. 2, global green bond issuance increases rapidly from US$37 billion in 2014 to US$508.8 billion in 2021, with an annualised compound growth rate of 45%. Among them, China's total green bond issuance in 2021 was RMB 1.16 trillion, with a CAGR of 45%. China's bond market ranks first in the world in green bond issuance. As of March 2023, the scale of green bond issuance in China's bond market was 1,594.44 billion, including 100 bonds of various types, such as financial bonds, corporate bonds, corporate bonds, medium-term notes, asset-backed securities and short-term financing bonds issued by 70 issuers. The number of issuances increased by 70.27% year-on-year (Chart 3).

Fig. 2. Global green bond issuance, 2014-2021 (in billions of dollars).

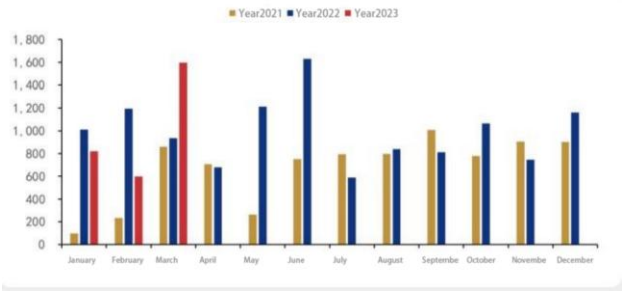

Fig. 3. Monthly green bond issuance amounts since 2021 (in billions of dollars).

IV. Drivers of Green Bonds (Causes, Influences)

A. Internal vs. External Drivers

The drivers of green bond generation can be classified as internal and external (Xiaqiu, 2022). The external drivers mainly include initiatives and guidance from regulators and policy incentives for green finance; the internal drivers refer to the fact that an increasing number of financial institutions are considering the environmental impacts of their investments as an advanced investment management concept (Table III).

1) Supervision and management by government agencies

In China, for example, the State Council, the People's Bank of China, the China Banking Regulatory Commission, the China Insurance Regulatory Commission, the Securities Regulatory Commission and other supervisory and regulatory bodies, as well as nongovernmental organisations, such as the China Banking Association, the China Securities Association, and the China Securities and Investment Funds Association, issue administrative documents and industry self-regulatory agreements to advocate for, or guide, financial institutions in the issuance of green bonds.

2) Policy incentives

To incentivise investors increase green investments, regions have implemented price subsidies for new energy and other important energy-saving and environmentally friendly industries. The financial subsidy mechanism for green bonds should be improved, the limitations of the subsidy standard should be gradually liberalised, and the period of subsidy should be reasonably delineated. Moreover, the declaration process of green bonds should be simplified, the time limit for approval should be improved, the amount of approval should be increased, green bond investors should be exempted from income taxes, and the deposit and loan ratio of green loans should be reduced. In the face of severe resource scarcity, serious environmental pollution and ecosystem degradation, government agencies have accelerated the pace of implementing green bond development.

3) Innovative investment management concepts

Investors believe that enterprises in line with the construction of ecological civilisation have more advanced technology in energy conservation and environmental protection, low carbon and green, which is superior to enterprises that are heavily polluting and resource-consuming. Additionally, enterprises focusing on green environmental protection themselves have a stronger sense of social responsibility and awareness of risk control and investing in this type of enterprise results in a stable return and a lower risk of default.

4) Fulfilment of social responsibility

The issuance of green bonds is in line with the expectations and requirements of all sectors of society for enterprises and helps them establish a favourable public image of assuming social responsibility and practising green development. When policies and public opinion pay more attention to social responsibility, and society's respect for such companies increases, the financial institution's reputation will also gradually improve, forming a virtuous circle.

5) Investor needs

Compared with ordinary bonds, green bonds have more stringent information disclosure requirements; thus, individual investors can invest their funds in "green" matters in a low-risk way. Doing so can not only obtain a certain return with lower risk but also fulfil social responsibility and meet diversified investment needs (Xu, 2016). Moreover, green bonds will also meet the needs of institutional investors. Insurance companies, pension funds, public welfare funds and other large institutional investors generally have long-term, sustainable

investment needs, which is in line with the concept of green bonds. In addition, the bond trading market allows investors to enter and exit at any time, providing a high degree of flexibility for liquidity management, which helps institutional investors adjust their portfolios in a timely and on-demand manner.

TABLE III. DRIVERS OF GREEN BONDS

Form	Driving Force	Element
External drivers	Supervise and manage	Regulators issue guidance documents to initiate and guide banks, trusts, and insurance Funds and other companies to promote green bond businesses
	Policy incentives	In terms of financial subsidies, tax incentives, optimisation of approval channels, reduction of A range of policy incentives in terms of refinancing and discounted costs.
Internal drivers	Innovative approaches to investment management	Incorporate green, low-carbon and energy-saving concepts into investment decisions to improve investment and financing, capital structure, optimise risk control and ultimately achieve higher long-term returns
	Fulfilment of social responsibilities	Financial institutions practising green bonds, while fulfilling their social responsibilities When to improve their own corporate image, improve enterprises' reputation, and then increase the recognition of financial institutions among their customers
	Investors need to invest	Green bonds have more stringent disclosure requirements and are lower risk; meet the needs of institutional investors such as insurance companies, pension funds and public interest funds

B. Drivers from Different Subject Perspectives

1) Government

The pressure on resources and the environment brought about by economic development, with pollution in the atmosphere, soil and waste constituting obstacles to the country's sustainable development, objectively motivates the government to promote changes in national strategy and the use of policy instruments to promote sustainability. Policy instruments can support the launch of a green bond market by establishing regulatory and enabling frameworks for green projects and green bond markets, while market participants should drive the market from the bottom up. The key role played by the public sector in market creation and providing guidelines and regulatory frameworks can further influence the private sector and the market (Wan, 2016).

2) Financial institutions

Issuing green bonds can fulfil their social responsibility, improve their risk management, and broaden their business development space. From the perspective of financial institutions as enterprises, issuing green bonds, developing green insurance products or making ESG investments are manifestations of their fulfilment of social responsibility and sustainable development, which is conducive to the construction of financial institutions' good corporate image (Chami, 2002). From the perspective of financial institutions' business development and risk management, issuing green bonds can be used as a tool to help financial institutions improve fund allocation and the analysis of their investment portfolios in terms of "environmental risk exposure" (Wang, 2019). The current financing model of the energy-saving and environmental protection industry is based mainly on green credit, and through the issuance of green financial bonds, the concept of green credit can be further combined with financial innovation to increase capital investment in the field of green finance (Wan, 2016). At the social responsibility level, issuing green bonds is also a social management initiative. Once an enterprise has negative impacts on society due to environmental damage, it is likely to cause environmental litigation. Environmental litigation involves not only polluting enterprises as defendants but also banks that provide credit to polluting enterprises.

3) Enterprises

The issuance of green bonds can be used to reduce financing costs and mitigate risks. Due to the relatively immature technology, large initial investments and other reasons, the investment risk of most green enterprises is high, and the issuance of green bonds can help alleviate the problems of financing difficulties and expensive financing. First, for some green enterprises, obtaining long-term financing from the bank is difficult; these enterprises often borrow new goods and repay old goods, which substantially increases the risk of capital breaks. If these green enterprises directly issue green bonds with longer maturities, they can substantially avoid the above risks. Second, if some green enterprises–as issuers of ordinary bonds–are temporarily unable to meet the requirements of regulatory authorities and the market (e.g., certain financial indicators)–but the green projects owned by these enterprises have good prospects–and are supported by relevant departments and have sufficient cash flow to support repayment, they can issue green bonds through the "green channel", which may be established in the future, allowing them to issue green bonds. However, if these enterprises have green projects with good prospects that are supported by the relevant authorities and sufficient cash flow to support repayment, they can issue green bonds through the "green channel", which may be established in the future to solve financing difficulties. Finally, as an important tool that contributes to the construction of ecological civilisation, green bonds are valued by the State, local governments and relevant regulatory bodies and are likely to be supported by relevant subsidies and preferential policies in the future,

such as dedicated interest rate support, lower investment thresholds and preferential taxes. This approach directly reduces the financing costs of green enterprises and enables them to obtain funds at lower interest rates. The opportunities and challenges posed by sustainable development are gradually changing corporate perceptions of the environment and society, and more enterprises are beginning to manage their risks through green bond issuances.

4) Investors

Investors currently have difficulty obtaining significant excess returns from investing in green bonds; however, these bonds are better than ordinary bonds in terms of asset safety and transparency. Investing in green bonds can help investors avoid credit risk to a certain extent and gain regulatory and reputation benefits. In terms of the implied ratings of all current surviving green bonds, green credit bonds are predominantly high grade, and the average qualification exceeds the overall credit bond level. As shown in Fig. 4, the distribution of green bond ratings in 2022 is dominated by AAA high ratings, accounting for 88% of the total. Compared with ordinary bonds, green bonds obviously have higher ratings. Moreover, the environmental degradation and investment damage caused by tightened environmental protection regulations are becoming increasingly important risks and challenges that investors must consider. Green bonds, which involve low-carbon and environmentally friendly project financing, are less likely to be affected by environmental changes and environmental protection policies, which can help investors avoid the resulting credit risk (Zhang, 2022).

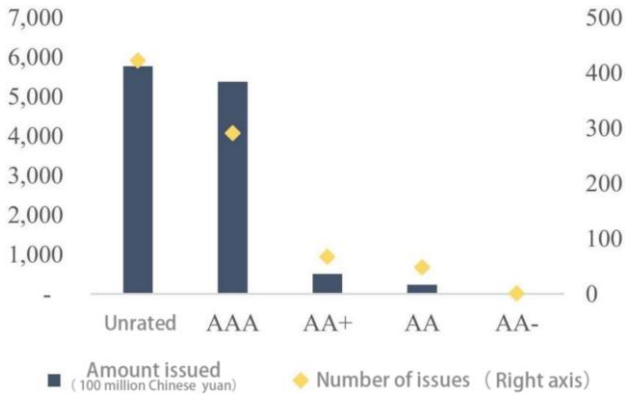

Fig. 4. Distribution of green bond ratings in 2022.

V. Effects of Green Bonds

A. Impact of Green Bonds on Financial Market Stability

Han *et al.* (2023) analysed the dynamic correlation between China's green bond market and other financial markets based on the ADCC-GARCH model and confirmed that the return on green bond investment is weakly negatively correlated with the return on stock and energy investments and that investing in green bonds may bring diversified returns to stock and energy investors. Li *et al.* (2021) showed that the external spillover effect of the green bond market, including treasury bonds, high-yield corporate bonds and the corporate bond market, is stronger than the spillover effect it receives from other markets, and the risk spillover between the green bond market and the traditional fixed-income market has high uncertainty. Reboredo *et al.* (2020) constructed a connection between the U.S. and European Union green bond markets and capital markets. Their study showed that green bonds have a strong interaction relationship with treasury bonds and corporate bonds in Europe and the U.S. in both the long and short terms. Yang (2023) studied the impact of green bonds on the risk-taking of listed commercial banks in China and found that conducting a green bond business can reduce the long-term risk-taking capacity of commercial banks.

Green bonds may exacerbate risks in financial markets, mainly in the form of liquidity risk in the green bond market. Based on the liquidity risk and yield of green bonds, it has been noted that the liquidity risk of green bonds is currently low, and the main reasons leading to the liquidity risk of the green bond market lie in the lack of supply and excess demand (Febi *et al.*, 2018). Given the continuous expansion of the scale of the green securities market and the further implementation of the open-door policy, capital liquidity in different markets is enhanced at the same time but also exacerbates the transmission of risk in the financial market. Moreover, the continuous adjustment in financial policy in the domestic market, as well as the continuous occurrence of unexpected financial events in the international market, further enhances the uncertainty of the risk transmission between markets. On the other hand, the instability of the international political and economic environment and the escalation of trade frictions have changed investor preferences, and investors may be inclined to choose financial assets with high flexibility and security, which may lead to a large-scale concentration of assets and further increase risks (Gao *et al.*, 2023).

B. Impact of Green Bonds on Business

1) The impact of green bonds on corporate performance

Several scholars have shown that issuing green bonds has a significant positive impact on and promotes corporate performance. Ouyang (2023) selected 4150 A-share nonfinancial listed companies in the second quarter of 2016–2022 as the total sample and 59 nonfinancial listed companies that issued green bonds during this period as the subsample. Using the propensity score matching model, we confirmed that the issuance of green bonds by listed companies can significantly improve corporate performance. Zheng (2020) used a double difference model to confirm that the issuance of green bonds has a positive impact on listed companies' economic performance and can significantly improve their returns on net assets. Wang (2023), based on quarterly data on green bond issuances and financings from 124 listed companies from 31 December 2017 to 30 September 2022, confirmed that the issuance of green bonds by listed companies has a positive impact on enterprises' business performance and that this positive impact is partly attributed to the fact that the issuance of green bonds reduces the cost of corporate financing.

2)The impact of green bonds on corporate share prices

The issuance of green bonds has a positive effect on causing a company's stock price to increase. Using PetroChina as an example, Yu (2023) found that the issuance of green bonds has a significant impact on a company's stock price. For large enterprises such as the CNPC, the issuance of green bonds has a stronger impact on the market; investors have more confidence in the company, believing that it actively responds to national policies, is conducive to industrial upgrades, and promotes green development, producing a more obvious short-term increase in the company's share price. Yang (2021) selected 673 green bonds issued in Shanghai and Shenzhen between 2016 and 2019 as the research object and studied the impact of issuing green bonds on corporate stock prices. Their results showed that government departments should formulate relevant policies to regulate the issuance market of green bonds, enabling green bonds to truly play a role in financing, which in turn stimulates market players' enthusiasm for participating in the issuance of green bonds. Chen (2021) showed that green bonds have higher information disclosure, and the issuance of green bonds by listed companies has a significant positive stock price effect in general.

3)Impact of green bonds on corporate finance

Green bonds are usually issued to finance a green project. The creditworthiness of the issuing entity, such as the World Bank, international development banks or government departments, is usually guaranteed. This approach makes full use of the advantages of debt financing while effectively avoiding its disadvantages (Chen, 2016).

4) The impact of green bonds on corporate green technology innovation

Several studies have shown that green bonds and corporate green technology innovation play a mutually reinforcing role. Li *et al.* (2023) used A-share listed companies in China's Shanghai and Shenzhen cities from 2010 to 2019 as a research sample and make the following four points. (1) Issuing green bonds helps promote the quality and quantity of enterprises' green technological innovation. (2) The analysis based on the characteristics of green bond issuance shows that a greater issuance amount and longer issuance period of green bonds are associated with a stronger promotion effect on enterprises' green technological innovation ability. (3) Enterprises' issuance of green bonds can improve their R&D investments, reduce the cost of enterprise financing, and enhance investor attention in three paths of enterprise green technological innovation. (4) The issuance of green bonds has a positive effect on green technological innovation in nonstate-owned enterprises and A-share listed companies in Shanghai and Shenzhen. The enhancement effect is more significant for the sample of nonstate-owned enterprises and for the western region. Moreover, green bond issuance can improve the degree of enterprise green technological innovation by reducing financing costs, alleviating maturity mismatches and improving information transparency (Qin, 2023).

5) Impact of green bonds on other aspects of business

Regarding the impact of green bonds on corporate performance, Ni (2023) selected A-share main board, small and medium-sized board, and venture board listed companies that issued bonds from 2016 to 2021 as the initial sample using a multitemporal double difference (DID) model to confirm that green bonds have a contributing effect on the financing efficiency of debt-issuing companies and increase corporate economic performance. Regarding the impact on enterprise value, Li (2023) used daily stock returns from 1 January 2016 to 30 September 2022 and the financial data of listed companies and found that green bond issuance by listed companies can also enhance enterprise value to a certain extent and that the financing cost and the tax rate have a mediating effect on the impact mechanism. Other scholars have reached the same conclusion and have found that green bond issuance by enterprises in the eastern region has a stronger effect on enhancing corporate value, and this effect is weaker for enterprises in the central and western regions (Wang, 2022). Li (2023) used quarterly panel data on 732 A-share nonfinancial listed companies from 2016 to 2020 and a multitemporal double-difference model (DID) to study the positive impacts of green bond issuances on corporate investments and the risk hazards of irrational corporate investment behaviours. The study explored the role of the mechanism from the perspective of financing constraints.

VI. Problems with Green Bond Issuance and Shortcomings of Current Research

A. Problems with Green Bond Issuance

At present, the overall environment for bond market development is favourable. As a new force, it is highly favoured by governments and has gradually attracted the attention of new energy enterprises and commercial banks. However, as a new investment and financing tool, the green bond market still has many problems.

(1) At the macro level, relevant policies and regulations are still inadequate. The Green Bond Principles issued by the International Capital Markets Association are less than 10 years old, and the overall policy and institutional construction of green bonds is still in a relatively early stage.

(2) At the meso level, the areas covered by green bonds are unevenly developed between industries. Green bonds restrict funding to areas that favour environmental protection and climate "mitigation and adaptation". However, bonds that raise funds for such projects may not necessarily be called green bonds, and although some local governments and other enterprises have issued bonds for energy efficiency and environmental protection, they only have ordinary bonds (Chen, 2016).

(3) At the micro level, the overall quality of market participants varies, and their responses are

inconsistent. As the classification of green bonds is still based on whether the issuer itself labels the bond as green, it is difficult to identify the bond's true greenness. In the absence of an authoritative third-party assessment and a systematic regulatory system, issuers with substandard green projects may also put on a green coat to raise funds at a lower cost.

(4) From the investor side, the oversubscription of issued bonds reveals a segment of the market that warmly welcomes green bonds, while other investors may perceive this type of investment as "new" or "unproven" risk and consider it a disqualifying asset (Kidney & Oliver, 2014). More individual investors may be neutral due to a lack of knowledge about green bonds.

(5) At the societal level, the overall understanding and recognition of green bonds is still low. The level of acceptance of green bonds in society as a whole can be reflected in the results of the research on green bonds. While practice is often the source of innovation and development, the systematic establishment of a concept is often spearheaded by academic research, which then facilitates its effective promotion in practice.

B. Gaps in Current Research

First, regarding the definition and connotations of green bonds, different countries have different national conditions, different financial markets and different regulatory mechanisms for financial markets; moreover, studies of the connotations of green bonds need to be combined with the national conditions of the study region and cannot be generalised. Second, regarding the driving force of green bonds, a description of the driving force of market competition on green bonds is lacking. Regarding the impact of green bonds, previous studies have focused mainly on the impact of green bonds on financial markets and enterprises but have lacked information on the impact of green bonds on the global ecological environment. The scope of the impact of the research is relatively narrow and is mainly unified from the economic perspective and lacks integration with the ecological environment system. Third, throughout this research, scholars have focused mainly on the existing situation of green bond issuance and its impact on enterprises, and research on the mechanism of green bonds has not been through enough.

VII. Suggestions and Prospects

A. Suggestions for Improving the Green Bond Issuance System

(1) Promote synergistic changes in the external institutional environment, the market trading system and the market regulatory system. The prerequisite for synergistic institutional change is that regulators and policymakers are able to recognise and acknowledge the meaning and role of green bonds and, thus, can remove legal and institutional barriers and provide professional safeguards for the development of this market.

(2) Give full play to the encouraging and guiding role of taxation and other policies. In addition to providing tax incentives, the government should give full play to the demonstration and driving role of green bonds issued by the public sector in leveraging green funds in the market and strengthen policy guidance. For example, the local government can encourage the establishment of industrial guidance funds and further stabilise the market for green bond issuance by allocating special funds.

(3) Improve the green bond rating and regulatory system. Quantitative indicators for analysing environmental impacts can be added on the basis of assessing the risks of green bonds. A "dual rating system" was adopted, i.e., the traditional rating criteria were retained, and separate green ratings were assigned at the same time. The awareness of the green development of the relevant market subjects can be further strengthened, the green rating of the bond-issuing subject can be directly linked to its bond financing costs, and it can be ultimately developed into an integrated rating system; i.e., the environmental rating is internalised into the overall rating (Jun, 2018).

(4) Widely mobilise and flexibly apply market forces. Different green projects have different investment scales, construction cycles, solidity and divisibility, etc., and their socioeconomic benefits are even more varied. In the face of an emerging and changing market environment, the government may have limited energy, and the market force is more flexible and can, in turn, promote smooth coordination and regulation. The first is the demonstration effect of the first mover on other industry players. If the first mover has a strong governance mechanism and a good reputation for issuance, it pressures and motivates subsequent debt issuers. The second is the monitoring role of project evaluation and guarantee units. The diversification of the identities of green bond issuers highlights the important role of evaluation and guarantees. The popularity of the concept of "green" may involve "reputational risk" for the issuer. Therefore, bond guarantee mechanisms should be improved, and third-party certification should be utilised for more prudent assessments of issuers and green projects.

B. Future Research Outlook on Green Bonds

Future research on green bonds can first focus on research related to the mechanism of green bonds. Moreover, green bonds are a kind of corporate bond, and corporate bond returns are composed of risk-free bond prices and corporate bond spreads. In turn, corporate bond spreads are composed of three components: credit spread, liquidity premium, and tax compensation. Future research can further analyse these five variables. Second, the development of green bonds is closely related to

topics of the ecological environment and global, and ecological systems should be included in future research.

VIII. Conclusion

Since the European Investment Bank successfully issued the world's first "climate awareness bond" in 2007, countries around the world have embarked on the process of issuing green bonds. In 2008, the World Bank and Sweden's SEB jointly issued the first Bond named Green Bond, which entered a rapid development phase in 2013. It has been defined by the EU Taxonomy, International Capital Market Association and Climate Bond Institution. Compared with ordinary bonds, green bonds, as an important financing tool in the green financial market, have more advantages than non-green bonds in terms of cost, efficiency, financial structure and use of raised funds. The initiative and guidance of regulators, the policy incentives of green finance and other external driving forces, as well as the innovative investment management methods of financial institutions and the investment needs of investors and other internal driving forces have made the development of green bonds endless. In recent years, many domestic and foreign scholars have used a variety of research methods to prove that green bonds have a positive impact on maintaining the stability of financial markets, improving corporate green technology innovation and corporate performance. However, as a new investment and financing tool, the green bond market still has many problems, such as related policies and regulations are still not perfect, and the overall quality of market participants is uneven and the response is different. Throughout the current research, this article puts forward suggestions from various aspects such as external institutional environment, market transactions, green bond rating and supervision and makes an outlook for the future.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Yuchen Ni conducted the research, analyzed the data and wrote the paper; Zhenna Huang collected relevant information; Xiru Liu modified the article; all authors had approved the final version.

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References

Chen, D. N. 2018. Stock price efficiency of green bond issuance by listed Chinese companies. ***Journal of Shanxi University of Finance and Economics,*** 40(S2): 35–38.

Chen, J. 2015. Research on China's green bond problem based on international experience [Unpublished Master dissertation]. Lanzhou University.

Chen, J. 2018. Study on the pricing of green bond issue in China [Unpublished Master dissertation]. Central China Normal University.

Chen, X. & Zhang, M. 2022. China's green bond market: Characteristics, facts, endogenous dynamics, and existing challenges. ***International Economic Review,*** 2022(1): 104–133.

Gao, Y., & Li, C. Y. 2021. Research on risk spillover effect between green bond market and financial market in China. ***Finance Forum,*** 2021(1): 59–69.

Han, Y. W., Gao, A. L., Li, S. Y., & Meng, H. 2021. A correlation study of China green bond market and other bond markets. ***China Bond***, 2021(5): 29–34.

Li, B. Y., Zhang, J. W., Shen, Y., & Du, Q. 2023. Research on the path and mechanism of the impact of green bond issuance on green technology innovation. ***Science Research Management,*** 44(11):134–142.

Li, M. Q. 2023. Study on the impact of issuing green bonds on enterprise value [Unpublished Master dissertation]. Anhui Agricultureal University.

Li, X. F., & Yu, X. Q. 2023. The impact of green bond issuance on investment behavior of listed companies: Based on staggered difference-in-difference model. ***Financial Theory & Practice,*** 2023(2): 48–56.

Ma, L. X., & Yu, J. 2023. Study on the impact of green bond issuance on stock price-taking petrochina shares as an example. ***Times Finance,*** 2023(4): 40–42.

Ni, L. L. 2023. Research on the impact of green bonds on enterprise financing efficiency: Based on the empirical data of China's green bond market [Unpublished Master dissertation]. Guilin University of Electronic Technology.

Ou, Y. Q. 2023. Study on the Impact of issuing Green Bonds on the Performance of Listed Companies. ***Times Finance,*** 2023(1), 35–39.

Qin, S. Y. 2023. The impact of green bond issuance on enterprise green technology innovation research [Unpublished Master dissertation]. Shandong University.

Wan, Z. H., & Zeng, G. 2016. International green bond market: Current situation, experience and enlightenment. ***Finance Forum,*** 2016(2): 39-45.

Wang, J. 2019. Driving factors and progress of green finance development in China. ***Reform of Economic System,*** 2019(5): 136–142.

Wang, M. X. 2022. The impact of issuing green bonds on the value of listed companies: Based on PSM-DID mode l. ***Journal of Jingchu University of Technology,*** 37(2): 57–63.

Wang, Y., & Xu, N. 2016. The development of Chinese green bonds and a comparative study of Chinese and foreign standards. ***Finance Forum,*** 2016(2): 29–38.

Wang, Y. M., & Tian, Y. 2023. Research on the impact of the issuance of green bonds on the business performance of listed companies. ***China Journal of Commerce,*** 2023(13): 109–113.

Xia, Q., & Dai, B. 2022. Driving factors, transmission mechanism and policy suggestions of green finance development. ***Gansu Finance,*** 2022(1): 38–41.

Xiao, X. M. 2017. Research on the development of the green bond [Unpublished Master dissertation]. Anhui University.

Yang, Y. M. 2021. Study on the impact of green bond issuance on corporate stock price. ***Northern Economy and Trade,*** 2021(6): 94–96.

Yang, Y. M. 2021. Research on the impact of green bond issuance on the company's stock price [Unpublished Master dissertation]. Hefei University of Technology.

Yang, Z. Z. 2023. Research on the impact of green bonds on the risk-taking among listed commercial banks in China [Unpublished Master dissertation]. Anhui Polytechnic University.

Zheng, C. L., & Luo, C. J. 2020. The impact of issuing green bonds on the economic benefits of listed companies: An analysis based on difference-difference model. ***Wuhan Finance,*** 2020(10): 38–44.