

## Retraction

# Retracted: China's Green Bond Market: Structural Characteristics, Formation Factors, and Development Suggestions—Based on the Comparison of the Chinese and the US Green Bond Markets Structure

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] H. Li, T. He, X. Liao, and W. Tong, "China's Green Bond Market: Structural Characteristics, Formation Factors, and Development Suggestions—Based on the Comparison of the Chinese and the US Green Bond Markets Structure," *International Journal of Antennas and Propagation*, vol. 2022, Article ID 1890029, 15 pages, 2022.

## Research Article

# China's Green Bond Market: Structural Characteristics, Formation Factors, and Development Suggestions—Based on the Comparison of the Chinese and the US Green Bond Markets Structure

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Since 2012, green bond markets have boomed worldwide, particularly in the European Union, the United States, and China. Under this background, the researchers use the methods of literature research, qualitative analysis, and descriptive research to compare the structure of Chinese and American green bond markets and analyze their differences from the perspective of historical evolution, issuance standards, and market operation characteristics. The researchers believe that China's bank-oriented financial structure and America's market-oriented financial structure are the main reasons for the difference between the two countries. The researchers then discuss the strengths and weaknesses of China's green bond market and conclude that the advantages of China's green bond market structure lie in low risk and close relationships between banks and enterprises, while the disadvantages lie in low financial efficiency and give relevant suggestions. This article makes up for the lack of cross-country comparison in the existing research on the green bond market and provides a qualitative research perspective. The suggestions put forward have specific policy significance for developing the green bond market in China and other developing countries.

## 1. Introduction

Since the 1950s, environmental issues have increasingly become the focus of international economic development, and many documents have been issued to promote the development of the green economy. Among the many factors that promote the development of a green economy, green finance plays an important role, and green bonds are the top priority.

Green bonds, also known as climate bonds, were first issued by the European Investment Bank in 2007. There is no unified definition of green bonds in the world, but the definitions of green bonds are generally similar. The World Bank defines a green bond as debt security issued to raise capital to support climate-related environmental projects

[1]. The People's Bank of China defines green bonds as the funds raised that are specifically used to support green industries, green projects, or green economic activities that meet the prescribed conditions. Among all the definitions, there are two main points in common. One is to raise funds for green, low-carbon, climate change mitigation projects; and the other is the financing method through the issuance of different fixed-income securities.

Due to the early development of the green bond market and the sound market system in the US, the annual issuance of green bonds is much higher than that of other countries. Recently, thanks to the popularization of the concept of a green economy and low-carbon environmental protection, the issuance of green bonds in China ranks second in the world. However, due to the issuer, issuance mechanism,

financial supervision, and other factors, there are many differences between China's and American green bond markets.

Therefore, this article uses the vertical and horizontal comparison method to compare and analyze the green bond financial markets between China and the US. In the vertical aspect, this article mainly compares the differences in the development speed and development trend of the green bond market between China and the US. In the horizontal aspect, this article mainly compares the differences in the green bond market between China and the US in finding the nature of the leading enterprise, the types of green bond issuers, and the credit rating of the issuer. Through the above horizontal and vertical comparison, the researchers conclude the main differences between the Chinese and American bond markets and determine the type of financial structure they belong to. Then, through qualitative analysis and literature research, combined with the existing literature on the analysis of financial structure, the researchers analyze the reasons for the differences between China and the US, draw the reasons for the differences between China and the US in the green bond market, and focus on the advantages and disadvantages of China's Bank-oriented green bond market. The data used in this article mainly come from two places. First, China's green bond data comes from the wind database. By the end of 2021, there are 1922 green bond data in total, mainly including the name of the green bond, the place of issuance, the relevant information of the issuer, and the amount of issuance. The data source of the US' green bond information is Bloomberg and Climate Bonds Initiative. In Bloomberg's data, the total issuance of all types of green bonds in the US has more than 20,000 data points with a time frame from 2010 to 2021. Specifically, for the credit rating of corporate green bonds in the US, only 228 active green bonds are available. The data of the Climate Bonds Initiative focus on the use of proceeds and type of issuers in the US green bonds market within a limited time frame from 2014 to 2021. The data are measured in billions of US dollars aggregated by the Climate Bonds Initiative and reorganized by us.

The researchers proceed as follows. In Section 2, the researchers provide a literature review of the existing research on the green bond market and financial structure to explain the current situation of green bond market research and the characteristics of bank-oriented and market-oriented financial structure and indicate the significance and innovation of this article. Then, in Section 3, the researchers compare China's and US green bond markets and illustrate their differences. Based on the result in Section 3, in Section 4, the researchers analyze the reasons for the differences between the Chinese and American green bond markets, and in Section 5 mainly illustrates the advantages and disadvantages of China's green bond market. Finally, based on the former reason analysis, the researchers put forward some suggestions to solve the disadvantage of China's green bond market in Section 6 and conclude the whole passage in Section 7.

## 2. Literature Review

*2.1. Green Bond Market.* With the rapid development of the global green bond market, the relevant research and literature on the green bond market are also enriching, especially the literature on China's Green Bond Market.

In terms of the development characteristics and influencing factors of the green bond market, Banga examines the potential and barriers for developing countries in the green bond market and concludes with recommendations for policies that can help to reduce market ineffectiveness and barriers [2]. From the perspective of the Chinese market, Gao and Ji conducted an empirical study on the influencing factors of the formation of green bond issuance credit spread from the perspective of the characteristics of green bond issuers and came to the conclusion that the green bond issuance credit spread has no significant relationship with the issuer's financial status and green certification and is opposite to the issuer's rating status [3]. Ba et al. used the utility maximization model to conclude that the reasons for the rapid development of China's green bond market are the national standards promoted from top to bottom, high issuance convenience, the implementation of policies promoted by state-owned enterprises, and differences in financing preferences, and put forward suggestions on clarifying access standards, unifying information disclosure requirements, and reducing tax rates [4]. Yang and Shi concluded that the public offering of green bonds is conducive to reducing the financing cost of enterprises, green policy support is the main factor affecting enterprise financing, and the financial cost of third-party green certification and bond issuing entities has no significant impact on the financing cost of green bonds by constructing the influencing factor model of credit spread of green bonds [5]. Zhang et al. studied the premium of China's green bonds by using the matching method. The results show that the yield spread of green bonds is 17 basis points lower than that of matched ordinary bonds, indicating that green bonds help reduce the financing cost of enterprises [6].

In the research on the relationship between the green bond market and other financial markets, Pham analyzed the volatility spillover effect between the return on investment in the US and found that there is a volatility spillover effect from the ordinary bond market to the green bond market [7]. Reboredo et al. found that the green bond market has a strong correlation with the corporate bond market, treasury bond market, and money market but a weak correlation with the stock market, energy market, and high-yield corporate bond market [8–10]. Du et al. analyzed the correlation between the international green bond index and the general bond index based on the DCC-GARCH model and found out that MSCI has a strong correlation with the yield series of the S&P 500 bond index. The dynamic correlation coefficient between the yield series of green bonds and traditional bond indexes shows a certain degree of instability, with sharp fluctuations [11]. Above all, there is a

clear connection between green bonds and other financial markets, especially the bond market, but there is no relevant explanation for the causal relationship between the two.

To sum up, in the research on the green bond financial market, the existing research focuses on the relevant factors that affect the development of the green bond market, the benefits of green bonds to the issue theme, and the relationship between the green bond market and other financial markets, but the existing research has the following two major problems: first, it focuses on the green bond market of a single country, and does not make a horizontal comparison of the green bond markets of different countries. Second, it is mainly analyzed from a quantitative perspective, and there is a lack of qualitative analysis of the reasons for the formation of China's current green bond market. Therefore, based on the existing literature, this article starts from a qualitative point of view by comparing the green bond markets of China and the US horizontally and vertically, summarizes the differences and causes between the green bond markets of China and the US, and then points out the advantages and disadvantages of China's green bond market and puts forward relevant suggestions, trying to supplement the omissions of the existing literature.

**2.2. Financial Market Structure.** Financial market structure is an essential part of financial development, derived from the financial structure, and becomes an integral part of the financial structure. Financial market structure refers to the existence, operation, mutual adaptation, interaction, and interconnection of financial sub-markets and their constituent elements in the economic system.

Financial structure is first proposed by Goldsmith and is definite as the form, nature, and scale of various financial instruments and financial institutions [12]. Franklin in his book *Comparing Financial System* compares the financial systems of some developed countries in detail and explores the positive effect of financial market structure on economic development [13]. Thus, the discussion on different financial market structures has been triggered. The later research on the financial market structure mainly focused on the comparison between the bank-oriented (Diamond, Gole and Sun) and the market-oriented (Zakaria, Ahmed and Wahid) financial market structure [14–17].

According to the function of the bank and market, the structure of the financial market is divided into the bank-oriented and market-oriented types. According to Levine, in the bank-oriented financial market structure, banks play a leading role in the financial market, financial resources are mainly allocated through banks, and banks play an active role in mobilizing resources, screening projects, monitoring management, and risk management [18]. The market-oriented financial market structure is on the contrary. According to Rajan, the market-oriented financial market structure is the allocation of financial resources through the market itself [19].

The differences between the two are mainly reflected in the following four points: (1) in the risk sharing mechanism, in the bank-oriented type, commercial banks bear the loss and default risk of enterprises, and depositors do not bear

the loan risk, but the systematic risk is large. In the market-oriented type, the losses or defaults of enterprises are directly borne by investors, which is easy to cause market fluctuations, and the risk of securities prices is large, but the system risk is relatively small. (2) In terms of supervision, in the bank-oriented type, banks mainly supervise the daily business behavior of enterprises, and investors have less supervision over enterprises. In the market-oriented type, investors directly supervise enterprises, care about the intensity of supervision, and require the regulatory authorities to supervise strictly. (3) In terms of financing, in the bank-oriented type, corporate bond financing is mainly realized through banks, and the issuance of bonds by enterprises is mainly through inter-bank issuance or by bank underwriters, while in the market-oriented type, on the contrary, enterprises can issue bonds directly in the market. (4) In the governance structure, the bank-oriented mainly relies on internal information, pays attention to the changes of loan collateral and guarantee, and the information disclosure system is not perfect. The market-oriented type requires strict accounting standards and external audit, perfect information disclosure system, and high transparency.

### 3. Analysis of the US and China's Green Bond Market Structure

**3.1. China's Green Bond Market Structure.** Since 2016, the market scale of China's green bond market has shown an upward trend year by year. By the end of 2021, China's green bond market has the following characteristics.

**3.1.1. The Issuing Scale Is Expanding, and the Issuing Field Is Mainly Interbank.** In terms of the issuance of green bonds, by December 2021, China had issued 1922 green bonds. The annual issuance scale of green bonds showed an upward trend. In 2021, the issuance amount of RMB green bonds was 611.506 billion yuan, showing an accelerated rebound. For the detailed of the scale of the China's green bond market, please refer to Figure 1.

From the perspective of green bond issuance sites, China's green bonds are mainly issued through Shanghai Stock Exchange, Shenzhen Stock Exchange, and the inter-bank bond market. China's inter-bank bond market refers to a market that relies on the China foreign exchange trading center, the central government securities depository and Clearing Corporation, and the inter-bank market clearing house Co., Ltd., including commercial banks, rural credit unions, insurance companies, and other financial institutions to buy, sell and repurchase bonds. The main underwriters of bonds are China's major commercial banks. From Figure 2, it appears that the inter-bank bond market dominates, and 58.8% of China's domestic green bonds are issued through the inter-bank bond market, which implies that the leading underwriters of China's green bonds are China's major commercial banks. Moreover, in the two-stock exchange, the main underwriters are also commercial banks, especially China's non-state-owned commercial banks, such as China CITIC Bank,

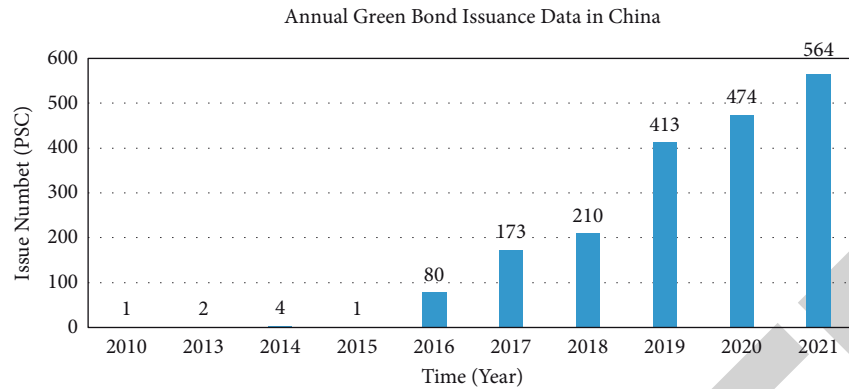


FIGURE 1: Annual Green Bond Issuance Data in China (Data source: wind, compiled by the author).

China Everbright Bank, and China Guangfa bank. Therefore, Figure 2 shows that the main underwriter

s of China's green bonds are China's commercial banks. Therefore, enterprises wishing to issue green bonds are mainly issued through major commercial banks or investment subsidiaries of major commercial banks in China.

**3.1.2. The Issuers Are Concentrated at a High Level, Mainly State-Owned Enterprises.** Judging from the ratings of green bond issuers, among the 1922 green bonds, 929 green bond issuers have recorded ratings. Among the 929 green bonds, the number of AAA grade bonds is the largest, accounting for 50.7% and the AA level is the second. A total of 922 bonds are rated above AA, and the lowest rating is BBB+, with only 1 bond. For the detailed of the scale of the China's green bond market, please refer to Figure 3. Generally speaking, the issuers of green bonds in China have high ratings and are a group with excellent and good credit.

From the enterprise nature of green bond issuers, central and local state-owned enterprises are the main issuers. Central state-owned enterprises and local state-owned enterprises accounted for 26.6% and 61.7%, respectively, private enterprises accounted for 6.6%, and public enterprises accounted for 3.2%. The total issuance number of enterprises such as wholly foreign-owned enterprises, foreign-funded enterprises, and Sino foreign joint ventures accounted for only 1.8%. See Figure 4 for details.

Above all, the researchers can conclude that China's Green Bond market's issuer comprises state-owned central and local enterprises with good credit ratings. Banks are the main issuers and underwriters of bonds. Therefore, the China Green Bond market is typically bank-oriented.

**3.2. The US Green Bond Market Structure.** The US is the most typical country in the application of market-oriented. Therefore, as a part of the US bond market, the US Green bond market is also a typical market-oriented bond market, which mainly has the following characteristics:

**3.2.1. Trend of Scale in the Issuance in the US and Issuance Market of Green Bond.** The US is the world's largest issuer of

green bonds, with \$395.9 billion in cumulative issuance. Figure 5 shows that in 2021, 4384 US bonds were issued, and the number of issuances increased by 23.3% from 2020, which is a record high.

As for the type of green bond, before 2019, Green bonds in the US are dominated by municipal and asset-backed security (ABS) bonds and account for more than 95% of total green bond issuance with around 70% of the total value of green bond issuance. After the continuous improvement of the standardization of the green bond market, low-interest rates in the market, and quantitative easing caused by COVID-19, there are more chances for enterprises to enter the green bond market. In the US, the main underwriter of American ABS is Fannie Mae, while corporate bonds are mainly issued through private placement and a public offering. The main underwriter of public offering is the American investment bank, and the private placement's main underwriter is the enterprise itself. Therefore, the main underwriter is not a commercial bank, whether ABS or corporate bonds. The inter-bank issuance market of US Green bonds is small, and the main circulating green bonds in the market are not issued through banks as underwriters.

**3.2.2. Credit Ratings and the Types of Green Bond Issuers in the US.** Among the credit rating of green bond issuers in the US, 228 activate green bonds with credit rating records. In the distribution of the credit ratings, Figure 6 indicates a normally distributed histogram with a mode at BBB+. Around 22% of the green bonds are below the investment grade (BBB-), and the minimum credit rating is B which is considered a speculative bond with high risks. Only 5% of the green bonds with an AA credit rating or above, and the premium to high investment grade (AA- to AAA) participate in less than 10% of the market.

For the type of issuer of the US Green Bond, from Figure 7, the researchers can see that the asset-backed security bond has been the most significant type of issuer in the green bond market since 2016, and it suffered a severe decline after the pandemic in 2019. In the situation of low-interest rates, quantitative easing, and strong government policy support, the economic recovery has brought private sector issuers back to the market. In 2021, nonfinancial corporate green bonds

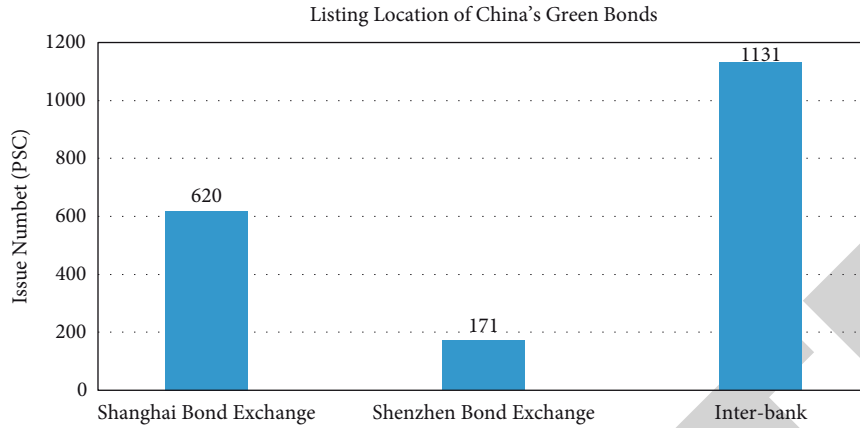


FIGURE 2: Listing Location of China's Green Bonds (Data source: Wind, compiled by the author).

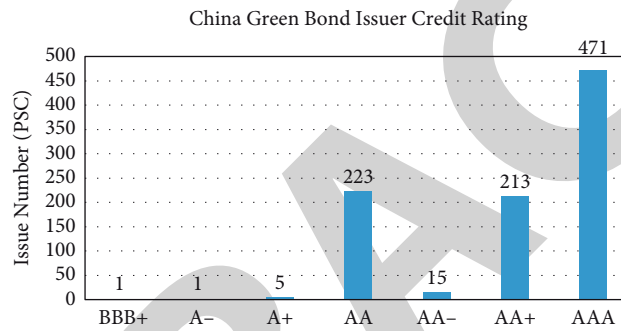


FIGURE 3: Credit Rating of China's Green Bond Issuers (Data source: wind, compiled by the author).

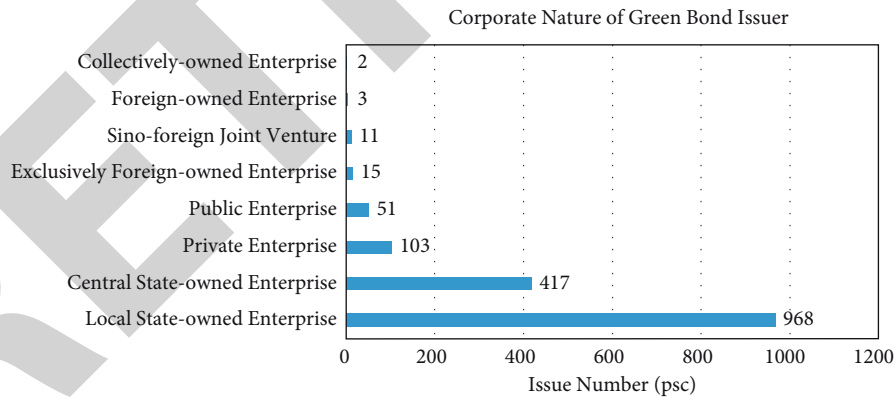


FIGURE 4: Nature of China's Green Bond Issuer (Data source: wind, compiled by the author).

increased by more than tripled, and government-backed entities green bonds increased by more than doubled each year in the last 5 years. The increase in nonfinancial corporate issuance has dramatically increased market activity and capital allocation efficiency. The largest issuer of the financial corporation in the US is Digital Realty Trust, which finances projects for low-carbon buildings. Second and third are Citigroup and Bank of America, which help to provide sustainable green loans for companies that do not have direct access to the capital market. Therefore, the researchers can conclude that the US green bond market is more diversified,

with both state-owned and private companies taking up a certain proportion.

3.3. Comparison of Green Bond Market between China and the US. From the value and quantity of issuance perspective, China's green bond market has grown steadily and rapidly after 2015. In 2019, after the *Green Industry Guidance Catalogue* was released, the growth of the Chinese green bond issuance number doubled. In contrast, although the US green bond market is generally on the rise, the US is not

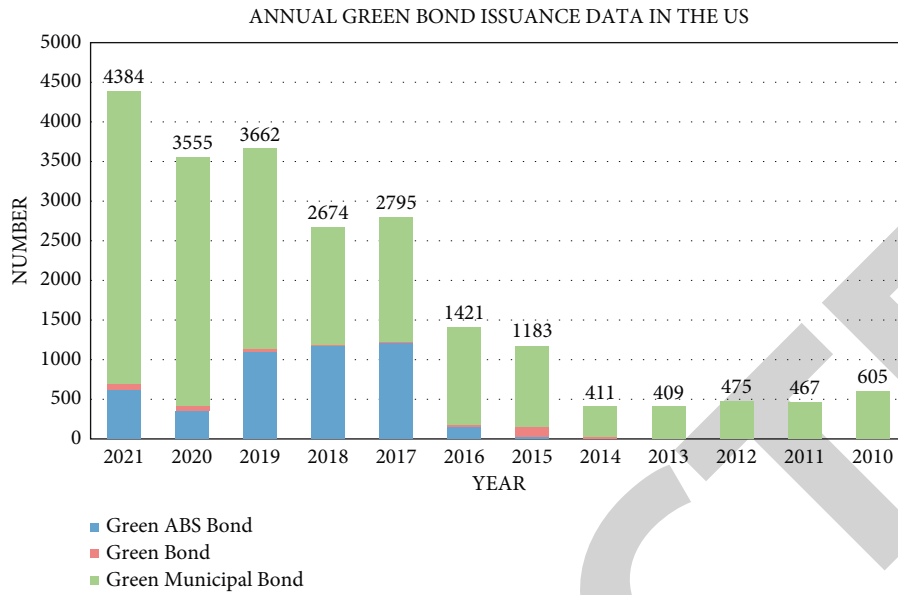


FIGURE 5: Annual Green Bond Issuance Number in the US (Data source: Bloomberg, compiled by the author).

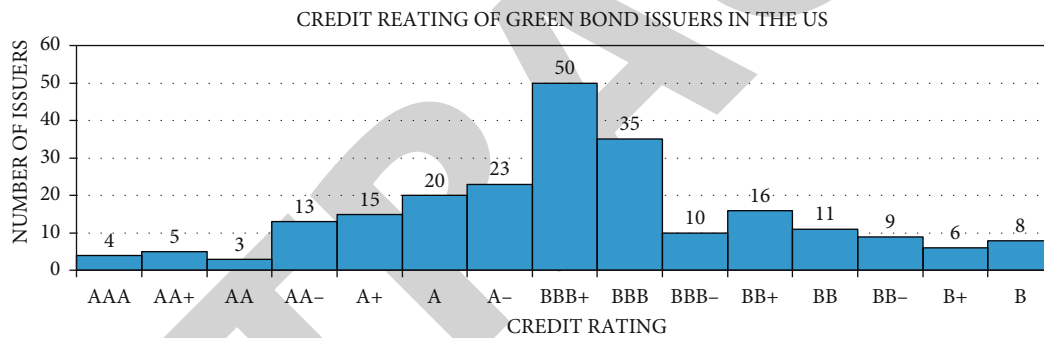


FIGURE 6: Crediting Rating of Green Bond Issuers in the US (Data source: Bloomberg, compiled by the author).

particularly stable, and the decline of the green bond market is easily affected by external risk factors and government policies.

From the perspective of credit rating, the credit rating of green bond issuers in China is extremely skewed toward prime and high investment grade, which is above AA. In the trend of issuance, the proportion of high-grade bonds issued in China has increased significantly each year, and medium to low-grade green bonds are rarely issued in the market. Furthermore, there are no bonds from issuers with credit ratings below BBB. In comparison, the credit rating of the US green bonds is normally distributed from AAA to B, with a single mode at BBB+.

From the perspective of the types of issuers, China’s green bond market is still mainly made up of government-backed, local state-owned, and central state-owned enterprise bonds, accounting for more than 70% of the total number of issuances and more than 90% of the total issuance value. The issued value of non-state-owned enterprises only accounts for less than 5%. Under the US green bond market,

the number of issuers is mainly composed of Fannie Mae as Agency MBS and local governments or government-backed entities, accounting for more than 95% of the total number of issuances, but each issuance quota of municipal bonds and ABS is relatively small compared with corporate bond. In 2021, corporate issuers took over more than 50% of the market share due to the significant increment in the participation of nonfinancial corporations in the green bond market, which tripled the issuance of nonfinancial corporate green bonds.

Through the data analysis, the researchers found that China’s composition of the issuer’s type and nature in the green bond market is similar to the US before 2015, which was dominated by government-backed entities and local governments with a government background. Since 2016, Green ABS bonds in the US have significantly increased and dominated the development of the green bond market. In 2020, corporate bonds entered the market rapidly and drove the most significant proportion and growth of the green bond market in recent years.

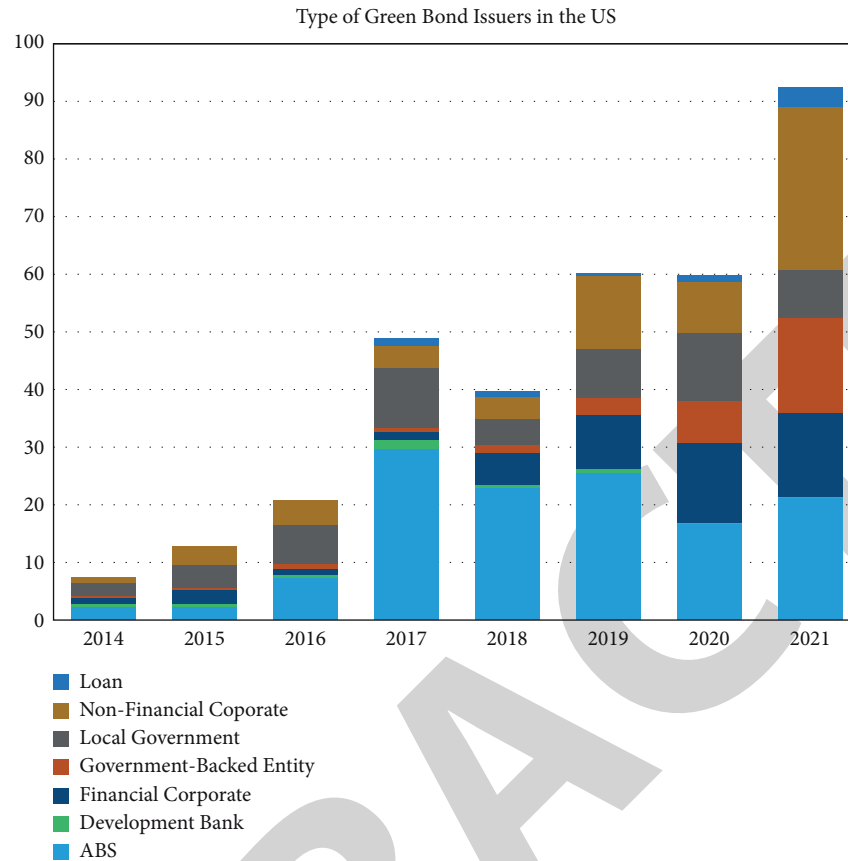


FIGURE 7: Type of Green Bond Issuers in the US from 2014 to 2021 (Data source: Climate Bonds Initiative).

#### 4. Reasons for the Differences in the Structure of the Green Bond Market between China and the US

##### 4.1. Investigation Based on Evolutionary Perspective.

Although theoretically speaking, there is no strict pros and cons between market-oriented and bank-oriented financial modes, only the difference in operating characteristics. However, compared with the US, China's current financial market structure dominated by state-owned banks show a big gap. If the researchers accept that such a gap exists, how does such a big difference between China and the US come about? In order to answer this question, the researchers must have a further understanding of the inherent differences in the structure of Chinese and American financial markets from an evolutionary perspective.

**4.1.1. US Green Bond Market Development History.** The spontaneous demand of market players mainly drives the development of the US green bond market, and the concept and rules are gradually formed through case accumulation. The first green bond in the US was launched in 2011, when the Yuba Community College District issued \$15 million in bonds to finance solar photovoltaics. Fannie Mae, the largest green bond issuer in the US, entered the green bond market in 2013, and since then, the US has seen rapid growth in green bonds.

As shown in Figure 5, the US Green bond market experienced tremendous growth in 2015, from 411 to 1183 entities, with a growth rate of 188%. Furthermore, after that, the US Green bond market ushered in rapid growth, and the number of issuers in 2019 was three times that in 2015.

With the rapid development of green bonds, the financiers of green bonds have become increasingly diversified. Early US multilateral development agency MBS (an ABS issuer type) was the primary issuer of green bonds. After 2015, the number of US municipal bonds (the type of issuer that is a local government or government-backed entity) has gradually increased. Later, ICMA and CBI issued "The Green Bond Principles, GBP" and "Climate Bond Standards, CBS," leading to a growing number of financial companies issuing green bonds. In 2020, green bonds issued by financial companies accounted for 20% of all green bonds issued.

In terms of policy, the US has not been as conscientious as other countries in addressing the impacts of climate change. Under the circumstance that the Trump administration pulled out of the Paris agreement, several banks, including Citibank, Bank of America Merrill Lynch, and JPMorgan Chase, pushed for the guidelines for green bond issuance to encourage the development of the green bond market. Fiske notes that these private entities helped guide the framework of US green finance, but their efforts were not followed up by regulators such as the SEC and the Federal Reserve [20].



After Joe Biden won the 2020 US presidential election, Climate issues and ESG development received renewed attention. The National Climate Advisor and the Director of the National Economic Council were assigned to develop a more standardized framework and standards for the green bond market. The Fed joined the Network for Greening the Financial System in 2021 to share regulatory practices and market activity data on risk management in green finance markets with other members in the system. In addition, Supervision and Financial Stability Climate Committees have been established by the Fed to better analyze the current risks and problems in the green financial market to ensure the rationality and efficiency of market capital allocation in the future. The efficiency of the capital market allocation is based on trust and credit, built on transparency and faithful representation of financial information among each entity. To facilitate the development and eliminate financial fraud of green bond markets, the SEC has established a task force on climate-related financial disclosures (TCFD) to investigate the misconduct of entities related to green debt securities.

*4.1.2. China's Green Bond Market Development History.* China's green bond market started nearly 10 years later than the international market, mainly following the "top-down" development model. The mode of policy-led and market institutions expansion is the typical model of China. China's Green Bond Market Development history can be divided into three stages.

Initial stage (2014–2015): at this stage, bonds supporting the development of green projects began to appear sporadically in China's financial market. However, since green bonds had not been defined at that time, these bonds with a "green bond nature" were not defined as green bonds. According to Figure 1, there is only one green bond issuer in the market.

Exploratory stage (2016–2018): green bonds are gradually normalized in this stage, and China's green bond market has achieved initial development. On December 22, 2015, the People's Bank of China announced the provisions for the issuance of green financial bonds and related matters, which determined the financing scope of green bonds, put forward the requirements for information disclosure and capital management, and introduced the third-party evaluation and certification mechanism. On December 31, 2015, the National Development and Reform Commission issued the *guidelines for issuing green bonds*, which defined the concept and funding scope of green corporate bonds. In 2017, the CSRC issued *several opinions on promoting the healthy development of green bonds*, advocating the transformation and upgrading of the green industry in exchange for debt service. With the implementation and encouragement of relevant policies, China's green bond market began to develop steadily, and the annual issuance of green bonds gradually increased.

Vigorous development stage (2019–now): at this stage, China's green bond market showed a blowout development, which benefited from the publication of a series of central documents. In 2019, the National Development and

Reform Commission, the People's Bank of China, and seven other ministries and commissions jointly issued China's first *Green Industry Guidance Catalogue*, which further clarified the definition and division of the green industry. In 2020, General Secretary Xi Jinping clearly stated that "carbon dioxide emissions will reach a historical peak point by 2030, and China will strive to achieve 'carbon neutrality' by 2060." Under this influence, on December 30, 2020, the government approved *Several Opinions on Accelerating the Construction and Improvement of a Green Ecological and Low-Carbon Circular Development Economic System*. In 2021, the National Development and Reform Commission, the Chinese Bank, and the China Securities Regulatory Commission jointly issued the *Catalogue of Green Bond-Backed Projects (2021 Edition)*, clarifying that the unified criteria for the identification of green debt projects will be used in China. Under the government's encouragement, in 2019, the issuer of green bonds doubled and increased by more than 100 each year, as shown in Figure 1.

*4.1.3. Differences and Impacts.* Through the above history of the development of the China-US Green bond market, the researchers can see that the US is a "bottom-up" model, taking the spontaneous demand of market subjects as the driving force, and gradually forming concepts and rules through case accumulation; China is a "top-down" model, and the government leads the evolution of financial market structure. This difference in the development model also leads to the difference in the structure of the green bond market between China and the US.

In the "top-down" development model, government behavior is an essential force in promoting the reform of the financial system, and state-owned enterprises are one of the essential tools for the government to promote its development. In China, the central and local governments introduce state-owned enterprises into the newly developed green bond market through policy guidance or index distribution, and state-owned enterprises also take the initiative to enter the green bond market to meet the merger and assist the national development policy. Therefore, state-owned enterprises have become central to the green bond market, as shown in Figure 4. In addition, under the background that financial regulation has not been fully liberalized and the domestic green bond market is relatively young, in order to ensure the smooth operation of the green bond market, relevant policies will improve the qualification examination of green bonds and then inhibit most enterprises with a low credit rating from entering, which help to explain that why the leading issuers of a green bond in China have a credit rating higher than A, showing in Figure 3.

In the "bottom-up" development model of the US, access to the green bond market is rarely limited by policies. The issuers in the market can issue green bonds freely according to their credit rating and corporate performance. In addition, the US currently has no special green bond standards at the federal level and lacks consistent official

development recommendations before 2021. The US government's swing attitude toward green bonds has also led to unstable growth and market composition trends in the green bond market. The US green bond market experienced a decline in 2020 under the policy of the Trump government, but the issuer increased dramatically in 2021 and reached a new high under Biden's government, as shown in Figure 5. The researchers can state that the US government's policies acted as a driver that led the direction of future development, which will have a moderate impact on the green bond market, but the market still dominates the development, and the financial institutions in the market play a decisive role. Therefore, the US Green bond market will show a very different phenomenon from China. The types of the issuer are more complex, including local government, development banks, non-financial companies, Fannie and Freddie, which explains the data in Figure 7; and the company from all credit rating access to the market, ranging from AAA to CCC +, explaining the data in Figure 6.

#### 4.2. Reanalysis from Green Bond Standard Perspective.

Due to the differences in the historical evolution of green bonds, China and the US have different standards for issuing green bonds. In China, there are two primary standards for green bond issuance, namely, *Catalogue of Green Bond Supported Projects (2021 Edition)* compiled by the Green Finance Committee of China Society of Finance and Banking and *Guidelines for Green Bond Issuance* issued by the National Development and Reform Commission. On the other hand, there is no specific green bond standard at the federal level in the US. Instead, individual states have issued voluntary standards adopted by issuers. However, all US standards are based on the *Green Bond Principles (GBP)* issued by the International Capital Institute (ICMA) and the *Climate Bond Standards (CBS)* issued by the Climate Bond Initiative (CBI). Therefore, to compare the differences between the issuing standards of green bonds in China and the US is to compare the differences between the issuing standards of green bonds in China and the issuing standards of green bonds in the world.

4.2.1. *Difference in Issuing Standards.* According to the information of the standard of China and US green bond issuing and the study of the cooperation between China and the US green bond standard (Wang Yao and Xu Nan), the researchers concluded that there are mainly three differences, which is the difference in project definition criteria, the difference in project directories, and the difference in the usage of money [21]. In terms of project definition criteria, in China, while developing the green bond project catalog, China also explains the project definition criteria. In the catalog, each project name is followed by a condition that green bond issuers must meet. Therefore, the issuance of green bonds in China does not depend very much on third-party certification. In the US, there are no standards that issuers in the US must adhere to, and there are no uniform criteria for rating. Each certification body will set the criteria

according to its principles. Typical examples are a series of industry standards developed under the leadership of the CBI, and the "second Opinion" issued by the Center for International Climate and Environmental Research (CICERO) to assess the green status of projects.

From the perspective of project directories, according to the information in Table 1, the researchers can see that although China and the US adopt different standards in the issuance of green bonds, there are many similarities in the issuance projects, especially in renewable energy, new energy, and the mitigation of global warming. Similarly, from Table 1, it can be seen that the differences between China and the US are mainly reflected in the green identification of nonrenewable energy projects. International standards GBP and CBS exclude nonrenewable fossil energy and any project that may extend its life cycle from the green category; China's green standards provide policy support for fossil energy-related industrial energy-saving technical transformation, export credit clean utilization of coal, and railway transportation projects. In addition, China's green bond projects pay more attention to pollution control and energy projects, and few projects related to sustainable development and biodiversity are involved.

Lastly, the usage of money is also different. In the US, the standard requires the issuers to the public the use of funds, submit a list of projects at least once a year, and regularly disclose environmental benefits. It emphasizes that the issuers independently disclose the flow of funds. It means that at least 95% of green bond funds should be green assets or projects. However, in China, the issuer only needs to disclose the use of the raised funds quarterly and does not need to disclose the flow of the funding. And the company is also allowed to use up to 50% of the funds raised by bonds to repay bank loans and replenish working capital. At the same time, issuers may not issue green corporate bonds or green debt financing instruments for specific green projects on the premise that the proportion of green industry revenue exceeds 50% and 70%.

4.2.2. *Impact of the Difference in Issuing Standards.* Due to the differences mentioned above in bond issuance standards between China and the US, bond issuers in the two countries have different access restrictions and incentives in the financial markets, thus leading to differences in the structure of green bond markets in China and the US.

The difference in the definition criteria means that China's green bond issuers are limited to certain areas, and companies not involved in these areas cannot obtain green bond issuance certification. China's large state-owned issuers occupy the leading position in these specific fields, while small and medium-sized issuers, especially private issuers, are challenging to get involved in. Moreover, the green bond standard in China's green bond market is not international and deviates from international standards. As a result, some domestic green bonds cannot be included in the international green bond database, which increases the transaction cost of cross-border investment of green capital and hinders the entry of foreign green bonds (Liu and Han [22]). On the

TABLE 1: Comparison of main green bond standards in China and the United States.

Standard name	Release time	The overlap of green project categories	The difference of green project categories
Catalogue of green bond supported projects (China)	2021	(i) Renewable energy (ii) Energy and building efficiency	(i) Clean utilization of coal. Oil, etc.
Guidelines for green bond issuance (China)	2015	(iii) Clean transport (iv) Waste treatment	(ii) New energy vehicles and fuel upgrades
Principles of green bonds (US)	2017	(v) Pollution prevention and control (vi) Water resources management	(iii) Emphasis on species conservation (iv) Exclude fossil energy projects
Climate bond standards (US)	2017	(vii) Land development (viii) Mitigation of climate change	(v) Exclude new energy vehicles and fuel upgrades

contrary, because there is no green distribution regulation in the US, each market authentication distributor has greater autonomy. As a result, under the issue of relatively flexible standards, some involving the green industry, but not fully green issuers also can issue green bonds. This will certainly include more issuers, especially small and medium-sized private enterprises.

In the project directories, China's standard has included additional renewable energy projects, namely the clean utilization of coal and oil and the upgrading of new energy vehicles and fuels. According to the characteristics of China's economy, most enterprises that fit in these areas are central or local government-owned enterprises. Therefore, from the above two points, the proportion of state-owned enterprises is relatively large in China's Green Bond market, which clearly explains why the Central state-owned enterprises and local state-owned enterprises accounted for 26.6% and 61.7%, respectively, of the Chinese green market. On the contrary, due to its wide range of support and broad access standards, the US Green bond market popularizes all sectors of society. Therefore, the researchers can see a wide range of types of issuers in the US and green bond market, just as shown in Figure 7.

From the perspective of incentives, the flow of funds raised by China's green bonds is relatively loose, and the funds raised can be used to repay corporate debts and supplement operations. Moreover, for issuers with AA+ credit rating and good operation, the raised funds can be used to replace the high-cost debt generated by green projects under construction. In this way, compared with the strict control of green bond capital flow in the US, China's loose capital flow control can stimulate the enthusiasm of issuers (issuers can alleviate the difficulty of capital turnover in operation by raising green bonds), and preferential measures for high credit rating are also easy to lead to the agglomeration of high credit subjects. In terms of incentives, China's green bond issuance standards lead to the agglomeration of high credit rating enterprises in the market, just as it shows in Figure 3 that the median credit rating of the issuer is AA+ and explain why the issuer increase as the rating goes higher. Moreover, the green bond issuance standards are relatively strict for non-green financial enterprises that are no longer within the specified scope. The business guidelines for green debt financing instruments of nonfinancial enterprises formulated by the China Association of inter-bank market dealers stipulate that all the funds raised by green bonds of

nonfinancial enterprises should be used for green projects that comply with the policy (Zhang and Chen [23]). This greatly reduces the motivation of non-green financial enterprises to enter the green bond market so that the existing market structure can be maintained.

*4.3. Reanalysis from the Market Operation Characteristics Perspective.* Theoretically, any financial market structure has two basic objectives: one is to allocate resources to the place with the highest utilization efficiency and the second is to ensure that the entity providing funds can obtain sufficient income compensation from the borrower. However, in the way to achieve these two goals, there are obvious differences between the market-oriented financial model and the bank-oriented model, and this difference leads to the differences between China and the US in the green bond market. Ying pointed out that there are obvious differences in market power, liquidity, innovative financing, and political controllability between the two financial financing models in China and the US [24]. Based on their research contents, this article summarizes and lists the differences in financial market structure between China and the US. See Table 2 for details.

In the market-oriented market structure and bank-oriented market structure, the transparency of market information is quite different. In the market-oriented structure, market transparency is based on a strict mandatory information disclosure system to ensure participants' confidence and maintain financial markets' existence. In the bank-oriented model, in order to limit market competition and ensure its monopoly position, when large-scale enterprises and financial institutions are associated with supervising the decision-making of enterprise managers, they will not express the real situation and decision-making process of the enterprise to the public. Then a large amount of information is the "private information" of institutions or enterprises. The transparency of the financial system is very low. The public mainly relies on the relevant information banks or large bond institutions give.

Therefore, bond underwriters, which are mainly banks, prefer enterprises with high credit ratings. The reason is that different from the bond company that chases for profit. The bank has a lot more social responsibility. According to the *national declaration on social responsibility of joint-stock*

TABLE 2: The difference between Bank-oriented Structure and Market-oriented Structure.

	Bank-oriented structure	Market-oriented structure
Response to price signals	Weak	Strong
Market forces	Strong	Weak
Mobility	Weak	Strong
Political controllability	Strong	Weak

*commercial banks* jointly signed by 13 joint-stock commercial banks in China, Chinese commercial banks should adhere to the promotion of a sustainable economy, fulfill their social responsibilities for social development, and safeguard the public social welfare. From the view of investors, because of the opacity of market information, investors prefer to choose issuers with high credit ratings because they believe that choosing one high credit rating company can effectively reduce the liquidity risk, default risk, and operational risk and can always sell bonds in the secondary market. Thus, the issuers with high credit ratings are more favored in the bank-oriented structure. As a result, just as shown in Figure 3, the issuer with a rating lower than A is almost excluded from China's green bond market and there is only one green bond issuer that is lower than A. China's green bond market is a concentration of high ratings. On the other side, in the market-oriented structure, because of the perfect information disclosure system, investors can have an in-depth understanding of the operating conditions of enterprises to make a reasonable evaluation, and the market dominated by financial institutions will more pursue interests and will accept all subjects in the society to issue bonds as much as possible. Therefore, as shown in Figure 6, credit ratings ranging from CCC to AAA all exist in the market, and the market appears as a normal distribution, which is what a regular large market should look like. The median is BBB+ and rare issuer in high or low credit rating. This phenomenon is unified with the balance of individual risk and return. Only a few people in the market realize the pursuit of high risk and high return and low risk and low return.

In addition, the effective operation of the market-oriented financial market structure must be based on sound external restraint mechanisms such as laws, accounting systems, and their implementation. This is because as long as they get the payment stipulated in the contract, the external investors who provide funds do not directly intervene in the operational decision-making. When the contract cannot be fulfilled, they can only get relief using external mechanisms such as collateral settlement and court. On the other hand, the core of the bank-oriented relationship financing model is that under the background of opaque information and lack of liquidity of assets, financiers rely on their special information advantage monitoring to reduce the agency problems of financiers, and then have relatively low requirements for external constraints, mainly relying on "subject reputation." Although China's regulatory authorities encourage the disclosure of information related to green bonds, it is not mandatory (Wang [25]). The regulatory authorities have not put forward suggestions on the caliber and consistency of disclosure, which exacerbates the reliance of investors on

credit ratings. From this point, it also proves the difference that Chinese issuers have higher credit ratings and American issuers are more diversified. In addition, China's relatively loose information disclosure mechanism will lead to the prevalence of greenwashing and greenwash. Once such incidents are discovered, the reputation of enterprises will be significantly affected, which will further reduce consumers' satisfaction with the enterprise brand and investors' trust in the enterprise and affect the stock price performance of enterprises (Chen and Zhang [26]). In China, private companies are more concerned about their reputations than state-owned ones, and listed companies are dominated by private companies, which also leads to a low desire for private companies to enter the green bond market.

Lastly, a bank-oriented structure has strong policy controllability. The government can directly regulate the bond market according to the needs of macroeconomic development through multiple ways, such as changeable monetary policy and interest rate adjustment. Meanwhile, central or state-owned enterprises shoulder political and social responsibilities. Their goals are more consistent with the operating characteristics of the bank-oriented structure compared with the private enterprises. Therefore, the central or local state-owned enterprises will account for a large proportion in the green bond market, and the private company, especially the foreign company, who do not want to follow the policy aim of the Chinese government will not want to participate in China's green bond market, the proportion of this kind of company will remain low, as shown in Figure 4. Furthermore, the market-oriented structure has weak political controllability. There is no obvious preference for enterprises, so private and public enterprises are equally to join it. In this way, there will be more diversity and the rating will be complex.

## 5. Pros and Cons of China's Green Bond Market Structure

Based on the above analysis of the differences between China and the US Green bond market and their reason, this article concludes that the structural characteristics of China's green bond market are jointly determined by the development process of China's green bonds, issuance standards, and the operation characteristics dominated by banks in China's overall financial market, showing obvious characteristics that Chinese green bond market is dominated by banks and dominated by state-owned enterprises. Any feature has both advantages and disadvantages. Therefore, in this part, this article analyzes the advantages

and disadvantages of the structural characteristics of China's green bond market.

### 5.1. *The Pros of the Chinese Bank-Oriented Market Structure.*

China's green bond market, dominated by banks and state-owned enterprises, has two main advantages: the overall risk of the financial market is small and the relationship between banks and enterprises is close.

To begin with, in terms of risk, the risks faced by the bond market mainly include credit risk, liquidity risk, and interest rate risk. China's green bond market has relatively less credit and liquidity risk than the market-oriented green bond market. In terms of credit risk, from the perspective of issuers, because China's green bond market is dominated by state-owned enterprises with central or local government credit endorsement and bond issuers with high credit ratings, the overall market credit rating is high, so the possibility of issuance default is relatively low. On the other hand, from the perspective of investors, in the bank-oriented green bond market, corporate defaults and losses are borne by commercial banks, and investors do not bear the main risk. From the perspective of liquidity risk, the recent study on the liquidity risk of the green bond market analysis from two aspects, Boutabba and Rannou find out that high-risk (resp. low-risk) investors buy short-term (resp. long-term) green bonds and hold them until maturity [27]. Chang et al. find out that the liquidity and credit rating have greater differences in affecting the yield spreads of green corporate bonds with different issuance terms and the higher credit rating means higher liquidity [28]. Based on the study, the researchers can conclude that because most green bonds are issued among banks and commercial banks buy and sell bonds on behalf of investors, investors can always sell their green bonds in time in the market and because the investor is diversified, no matter short or long green bonds can find a buyer. Moreover, because the credit rating of green bonds found in the Chinese market is high and the credit of the issuer is excellent, it can be used as a risk-free asset representing security in the portfolio, and there are always enough buyers in the market.

However, since banks dominate China's green bond market, it faces systemic risks caused by the bankruptcy of commercial banks. If the commercial bank goes bankrupt, the investors' investment will also be lost. Because the investors have a low understanding of the invested enterprise information and the business status of the commercial bank, they cannot predict future development in advance, resulting in greater systemic risk. After investigating the banks that underwrite and issue China's green bonds, it is found that China's green bond issuing banks are mainly China's six major state-owned commercial banks, three major policy banks, and national joint-stock commercial banks. These banks either have national credit endorsement or have massive funds and superior credit, so it is difficult to go bankrupt. The government will intervene and reduce losses even if there are capital flow problems. Therefore, there is no need to be afraid of bankruptcy and the systemic risks caused by that.

Second, from the perspective of the relationship between banks and enterprises, enterprises mainly raise funds through banks in the financial market dominated by banks. Therefore, banks have a close relationship with enterprises and have a deep understanding of enterprises' operation status and future development direction, especially mature traditional industries and large state-owned enterprises. Therefore, when issuing green bonds, because banks have a deep understanding of the issuing subject, banks can solve the problem of information asymmetry and reduce the cost of information collection. This way, it can give full play to the effect of economies of scope, reduce the issuance cost, and improve the issuance rate.

### 5.2. *The Cons of the Chinese Green Bond Market Structure.*

Although China's bank-oriented green bond market structure has the advantages of low market risk and close relationships between banks and enterprises, it also has unavoidable disadvantages, which are mainly reflected in the lower financial efficiency compared with the US market-oriented green bond market structure.

Financial efficiency is the efficiency of capital financing. Its connotation refers to those financial institutions that produce the largest output with the smallest input. The factors affecting financial efficiency mainly include micro subject factors and industrial factors.

*5.2.1. Micro Subject Factor.* The micro subject factor is the sustainable and healthy survival of micro-enterprises. From the perspective of finance, the main factors that endanger enterprises' sustainable and healthy survival are credit discrimination and banks' own operation defects. In China's financial market, credit discrimination is manifested in that China's state-owned enterprises face lower credit standards than individual enterprises, and state-owned enterprises have easier access to bank credit funds than the private sector (Bai and Lian [29]; Xing and Jin [30]). Moreover, government implicit guarantees will also lead to credit discrimination, resulting in resource mismatch. The government's invisible guarantee directly affects the preference of commercial banks for state-owned enterprises in the allocation of loan resources, encouraging the "reverse flow" of credit funds to inefficient enterprises (Ma et al. [31]).

The bank's operation defect mainly lies in the bank's conservative loan strategy to reduce its own risk. Baum et al. pointed out that macroeconomic risks increased the difficulty of risk assessment for bank managers, forcing them to adopt conservative lending strategies [32]. Under the conservative strategy, banks prefer enterprises with high credit ratings, and the bank-oriented financial market structure will expand this phenomenon.

According to the above two points, in terms of micro subject factors, due to credit discrimination and banks' operation defects, China's green bond market has a crowding out and exclusion effect on private enterprises, and a large number of private enterprises developing green industries or enterprises with low credit rating cannot obtain funds in the market. However, a high credit rating does not

mean high financial efficiency. Some enterprises with low credit ratings use financial funds more efficiently than those with high credit ratings. Therefore, there are inefficient issuers of high credit ratings in China's green bond market, while there are efficient issuers of low credit ratings outside the market. The inefficient issuers obtain a large number of financial resources, while the efficient issuers cannot obtain financial resources, which damages the efficiency of the financial market.

**5.2.2. Industrial Factor.** As for industrial factors, industrial agglomeration and industrial structure innovation are the keys to promoting financial efficiency. Ehrlic and Seidel concluded that industrial agglomeration helps to reduce information asymmetry in the credit market and maintain the relationship between enterprises, thus enabling high-quality enterprises to obtain more bank loans [33]. Lu and Xiao proposed that upgrading and rationalizing industrial structures could help improve the efficiency of financial development [34]. The Chinese green bond market structure has a much lower promoting effect on these two points than the US green bond market structure.

Industrial agglomeration needs a large number of small and medium enterprises in the same area of agglomeration. In the US green bond market structure, small and medium-sized can better access capital and thus realize industrial concentration. However, the Chinese green bond market structure is not conducive to small and medium-sized enterprises, thus difficult to achieve industrial concentration.

In the upgrading of industrial structure, as Allen pointed out, a market-oriented financial market structure is more conducive to industrial innovation than that dominated by banks [35]. In China's green bond structure, on the one hand, the complexity and uncertainty of the high-tech transformation project itself are very prominent, which objectively becomes a high-risk activity. On the other hand, high-tech enterprises in their early stage have few tangible assets. Thus, their capital needs are in fundamental conflict with the credit principle of the bank, and it is difficult to obtain bank credit and financial support. In US green bond market structure, market mechanism to realize low-cost integration of industrial structure, develop the superiority of high and new technology, and create good conditions for innovation and its diffusion, and bond market mechanism and the way to promote industry structure adjustment and exit, to speed up the upgrading of industrial structure, to enhance the overall competitiveness of the industry.

## 6. Future Development of the Chinese Green Bond Market

From the discussion above, the researchers show that the Chinese green bond market has obvious problems in financial efficiency. Therefore, in the last part of this article, the researchers tentatively put forward some optimization schemes and ways.

Among the overall financial market optimization schemes, Chinese scholars have put forward several internal

and external factors that restrict the development of China's financial market structure (Li et al. [36], Wu [37], and Wang [38]). In order to overcome these factors, Li and Wu built a standard system and proposed that the core content of optimizing China's financial market structure mainly includes three aspects: rationalization, advancement, and granitization [39]. Wang reached the same conclusion from the institutional economics perspective [40]. On the specific optimization path, Wu and Hu proposed that the optimization should be carried out from the aspects of levels, space, behavior, and supervision [41]. Therefore, referring to the research scheme of the above article, our article put forward the recommendations for the future Chinese Green Bond Market development from three dimensions.

The first dimension is rationalization. Rationalization in the financial market refers to the ability of various sub-markets in the financial market to balance and adjust with each other through the needs and goals of economic development. (Guanfeng Wang) Through the analysis of the green bond market, the main problem in China's green bond market is the asymmetry between demand and supply, resulting in the inefficiency of the green bond market. While China currently has a relatively complete green bonds issue standard and classification, non-state-own, small-medium, and other corporations in the green industry still rarely participate in the green bonds market. The fundamental reason comes from the distorted financial structure of China's bond market. In the market, state-own corporation green bond account for more than 90% of the market. Non-state-own enterprises only issued 5% of the debt, indicating the low marketization level and irrationality in China's bond market. Therefore, it causes many of the small-medium corporations and corporations from the green industry cannot effectively raise funds from the current financial market. From market supervision, the setup of China's bond market supervision agency is also irrational. In the US, the bond market is supervised by THE SEC. While in China's bond market, there are six regulatory agencies overseeing different types of bonds separately and commonly, including the People's Bank of China and the China Securities Regulatory Commission. In this case, the low efficiency of agencies and the inconsistency of policies in each agency will become potential obstacles to the development of the green bond market. In order to have further development in the green bond market, the problems in the bond market must be solved first by institutional reform and revolution on the marketization in the bond market.

The second dimension is advancement. Advancement refers to improvement under rationalized financial markets from simple to complex, low to high, and closed to open. The researchers believe that the development of third-party certification systems is necessary and should be strengthened to help improve the efficiency and regulation of the green bond market. For the financial information of the corporation, the faithfulness and completeness of information disclosure of the corporation's green projects should be further improved and implemented in the issuance of green bonds. Regulators could set up independent audit teams or task forces to ensure the use of funds raised and

the standardization of companies' green projects, which would help reduce companies' use of green bonds for misconduct. The researchers suggest promoting the internationalization of China's green standards to reinforce China's green bond influence in the international financial market and promoting the integration of green bonds in the domestic and foreign markets to expand the market influence. Ultimately more overseas investors can participate in the development of China's green bond market, which helps to increase the liquidity and efficiency of China's green bond market.

The third dimension is gradient. The granitization of financial market structure refers to the gradual development of financial market structure from small to large, from single to multi-layer, and so on. According to the above data, the types of bonds in China's green bond market should be more diversified. The form dominated by a single enterprise or government bonds should be transformed into a multi-level jointly dominated form, especially the introduction of asset securitization. In the future, China's green bond market should follow the European and American green bond market structure, build three tripartite situations of traditional bank intermediary credit, market credit, and asset securitization, meet different needs in actual finance, and form a complete financial system and realize gradient development.

## 7. Conclusion

China's green bond market started 10 years later than the US, but its scale has been developing rapidly and steadily in recent years, becoming the world's second-largest green bond market. After comparing it with the US Green bond market, this article finds that the structure of China's green bond market is dominated by state-owned enterprises and high credit rating issuers. This feature of China's green bonds is due to the top-down development model of China's green bond market, relatively strict green bond issuance standards, relatively loose information disclosure standards, and a bank-oriented market structure. However, each bond market structure has both advantages and disadvantages. Although China's green bond structure reduces the internal risk of the whole market and reduces the search cost of enterprises, it has seriously damaged the financial efficiency of China's green bond market, resulting in the low financial allocation efficiency of China's green bond market. Therefore, this article puts forward the following three suggestions for future development, which means that China's green bond market needs to achieve rationalization, advancement, and granitization.

This article provides relevant help for future research from the following three aspects: first, this article makes up for the omissions in the existing research on green bonds. By using the horizontal and vertical comparison method, this article makes a comparative study on the market structure of green bonds between China and the US, which helps to promote the understanding of the impact on the development of green bond markets in different countries, and provides some reference for the follow-up study of the

differences in the structure of green bond markets in various countries. Second, this article analyzes the green bond market from a qualitative perspective, which is helpful to deepen the understanding of the green bond market, deepen the understanding of the factors affecting the development of the green bond market structure and the advantages and disadvantages of different green bond market structures. Third, this article analyzes the existing defects of China's green bond market and puts forward relevant suggestions, which will help the development and improvement of China's green bond market in the future, and also provide theoretical support for the development of green bond market in other developing countries.

For future study, the researchers think there are two main ways to go deeper. First, the introduction of quantitative methods to further determine the different factors that affect the formation of different green bond markets in different countries and rank their importance, trying to find out the decisive factors. The second is to study the relationship between the green bond market structure and other bond market structures and the impact of different green bond market structures on other bond markets.

## Data Availability

All data, models, and code generated or used during the study appear in the submitted article.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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