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The Impact of Green Bonds Issuance on Company Risk-Taking Level

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Abstract: Promoting green transformation is one of the key methods to achieve the goals of "carbon peak" and "carbon neutrality". In reality, however, a great number of companies are reluctant to invest in green projects out of fear of the associated risks. At this point, the issuance of green bonds may serve to enhance the company risk-taking level, it is meaningful to study the correlation between the two variables. This paper uses the data of Shanghai and Shenzhen A-share listed companies to empirically analyze the impact of green bonds issuance on the company's risk-taking level. It is found that the green bond issuance can significantly improve the company risk-taking level, and the R&D expenditure can work as a mechanism. In addition, the impact of green bond issuance is also varied between polluting companies and non-polluting companies. In the future, when the green bonds policies are further optimized, every country can participate in the protection of the environment more actively.

Keywords: Green Bonds, Risk-taking Level, Green Transformation, R&D expenditure

1. Introduction

To alleviate the negative influence of fierce climate change, various countries worldwide have focused on the reduction of carbon emissions since "*The Paris Agreement*" was signed in 2015. Among these countries, China is striving to achieve the goals of "carbon peak" and "carbon neutrality", thus helping to maintain the stability of the global climate. Nevertheless, achieving the "dual carbon" goals is no easy feat. Companies in all industries should be encouraged to undertake environmental responsibilities so as to promote green transformation. Moreover, this process has potential risks. Out of fear of losses, some companies may tend to maintain a low level of risk-taking, which impedes their own green transformation and even the process of goal attainment.

Specifically, green transformation is accompanied by a series of environmental regulations which can stimulate the innovation and improvement of companies through exerting proper pressure [1]. Companies have to allocate capital from their main business to invest in green projects. This action will cause fluctuations in the profitability and lead to the increase of risk-taking level. From this point, the increase of risk-taking level may mean that companies are actively carrying out green projects, but there are still some companies refuse to take risks. Due to limited funds, market competition or other factors, some companies have difficulties in promoting green transformation, and some even choose "greenwashing" to shirk the responsibility of protecting the environment [2]. These phenomena are not conducive to the realization of the "dual carbon" goals. Therefore, how to encourage companies to take risks and promote their green transformation still awaits exploration.

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As a part of the green finance system, green bonds might have the ability to change the situation. In 2023, the scale of new green bonds issuance in China is about 838.87 billion ¥ and the cumulative scale has reached up to 3.62 trillion ¥, which represents that the green bonds market of China is thriving. In this market, investors with climate-awareness are willing to purchase the green bonds, which specially raises capital to finance or refinance the qualified green projects [3]. Through systematic management, companies can make full use of the fund to meet their financial needs. In this way, companies may further bear a certain level of risk and comply with the inevitable trend of green transformation. The impact of green bonds issuance on the company risk-taking level is worth researching.

The differences and marginal contributions of this paper may be: (1) Some scholars have found that companies with managerial risk-taking tendency are more likely to pursue the long-term value through innovation [4]. This risk-taking behavior is spontaneous. Differently, this paper tries to study that under semi-mandatory pressure like green transformation, what problems companies might meet when they have to take risks, and how green bonds can help them to overcome the difficulty. The discussion can provide theoretical supplements for risk-taking field. (2) Companies with higher risk-taking policies are more likely to increase their R&D expenditure [5]. However, this paper exchanges the position of risk-taking level and R&D expenditure to explore whether R&D expenditure has a mechanism effect. This can offer a new perspective. (3) Both polluting and non-polluting companies can issue green bonds if they reach the standard. This paper uses heterogeneity analysis to test whether there is discrepancy on the effect of green bonds issuance between the two types of companies. The outcome may be meaningful to improve the green bonds policy.

In order to empirically examine the relationship between the issuance of green bonds and the risk-taking level of companies, this paper utilizes the data of Shanghai and Shenzhen A-share listed companies to carry out the staggered difference-in-difference (DID) regression analysis. The remainder of this paper is organized as follows: Section 2 describes the literature review. Section 3 develops the research hypotheses. Section 4 provides the research methodology. Section 5 demonstrates the empirical analysis. Section 6 presents the conclusion.

2. Literature review

2.1. Green bonds

Green bonds are a type of fixed-income security specially designed to finance the environmental projects. Like other green financial instruments, green bonds aim to internalize environmental externalities [6]. Bond-issuing companies will regard improving environmental performance as a priority in their daily work, which will lead to an increase in their investment in environmental protection.

The existing literature primarily investigates the economic consequences of green bonds on three aspects. They are internal shareholders, external investors and companies themselves. As for internal shareholders, the announcement of green bonds issuance leads to a positive stock market reaction. The liquidity of stocks will increase, thereby augmenting the wealth of existing shareholders [7]. As for external investors, although the returns on green bonds are lower than normal bonds, purchasing them can still satisfy investors' non-pecuniary preferences for environmental protection [8]. As for companies themselves, the issuance of green bonds have a positive impact. Companies' financial performance and corporate social responsibility are promoted a lot [9]. Apart from the economic consequences, scholars also demonstrate that green bonds indeed have the positive environmental influence. The assets of some green bonds issuers are spotted to decrease in their carbon intensity, which proves that green bonds can lower the carbon emissions significantly [10]. These findings reveal the different impact of green bonds explicitly.

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2.2. Risk-taking level

Return is associated with risk. To pursue higher future value, companies need to take more risks. After taking into account various factors, different companies will choose their own risk-taking level.

The relevant literature has studied the factors influencing the risk-taking level, and many of them are from within the companies. First, as the core of a company, large shareholders can decide whether to take risks. When large shareholders have controlling interests in diverse companies, their utility will not be drastically reduced by loss of a single company. As a result, they may encourage companies to take risks to seek higher profits [11]. Second, to maximize the profits of shareholders, managers should act to take risks. If the whole company has a risk-taking climate, the managerial risk-taking propensity can be further stimulated. Managers will try to innovate which increases the risk-taking level [4]. Third, under the perceived organizational support from managers, other employees are also willing to accept the uncertainty and try to take risks [12]. The three factors occur consecutively in time and together contributes to the increase of risk-taking level.

3. Research hypotheses

3.1. Green bonds issuance and risk-taking level

To reduce pollution and emissions, companies have to invest in green projects. However, these projects can't generate much revenue rapidly. Once the income and expenditure are out of balance, companies will encounter dramatic profitability fluctuation. This dilemma prevents companies from taking risks to promote their green transformation.

At this time, the issuance of green bonds can help. Characterized by mandatory green investment and high-standard certification, green bonds can serve as a reliable signal of the company's commitment to the environment, thus attracting many eco-friendly or risk-averse investors [13]. Then, by taking advantage of the green bonds' pricing premium and low interest rate, the issuers of green bonds can raise a large amount of capital at a lower cost than normal bonds. As a result, companies can get rid of the concern about financing constraints. They can bear risks to carry out green projects with the assistance of green bonds, which increases their risk-taking level. Moreover, in the long term, companies can obtain additional return from the developed green projects. After repaying principal and interest of green bonds, companies can be more capable of taking appropriate risks to pursue the enhancement of their own value. This lead to the hypothesis 1:

H1. *The green bonds issuance can enhance the company risk-taking level.*

3.2. Green bonds issuance, R&D expenditure and risk-taking level

Green bonds have the attributes of both market incentive and environmental regulation. When it comes to market incentive, through issuing green bonds, companies can get the opportunity to raise funds on capital market. This can bring about the focus of investors with environmental preference. If companies want to maintain their market credit, they must correctly invest the capital in green projects in order to reach the investors' expectation. Moreover, the implementation of green projects involves the use of technologies. Companies have to increase their R&D expenditure which increases the risk-taking level at the same time.

When it comes to environmental regulation, according to Porter's hypothesis, appropriate environmental regulation will motivate companies to engage in innovative activities. The rules of green bonds in China are similar to environmental regulation because they are approved by CSRC (China Securities Regulatory Commission) and other government departments. Issuers of green bonds must disclose the use of funds regularly, or they may face punishment. As a result, the stakeholders can exert supervision on companies effectively. Under such pressure, companies will

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dedicate themselves to developing green projects. They may strive to master green technologies through increasing the R&D expenditure. During this process, continuous investment without instant revenue will escalate the volatility of the companies' financial performance, which is shown as the increase of company risk-taking level. After this process, companies can rely on their unique technology to achieve additional revenue and attract more investors. With adequate funds, companies can better bear the risk of loss. This leads to the hypothesis 2:

H2. *The green bonds issuance can increase the R&D expenditure, thus enhancing the company risk-taking level.*

4. Research methodology

4.1. Data description

This paper selects the data of Shanghai and Shenzhen A-share listed companies from 2019 to 2023 as the initial sample to explore how green bonds issuance affects company risk-taking level, and the relevant data are obtained from Wind and CSMAR databases. In addition, due to the problems such as missing data and outliers, this paper carries out the following treatments: (1) exclude the sample of listed companies in the financial industry; (2) exclude the sample of listed companies with special treatment such as ST and PT; (3) exclude the sample of listed companies with large areas of missing data; (4) linearly interpolate for a small portion of the missing indicators; (5) select the sample of mature companies that were established before 2008; (6) in order to mitigate the impact of extreme values, some continuous variables are at the upper and lower 1% quartiles.

4.2. Variable definition

4.2.1. Dependent variable

Company risk-taking level (*Risk*) is the dependent variable in this paper, which can be measured by the volatility of *ROA*. Following the previous study [14], *ROA* is calculated from dividing *EBIT* by total assets at the end of the year. Adjusted *ROA* (*Adj_ROA*) is calculated by *ROA* minus industry *ROA*. Ultimately, this paper uses the standard deviation of adjusted *ROA* in the last three years as the company risk-taking level. The specific calculation formula is:

$$\mathrm{ROA_{it}} = \frac{\mathrm{EBIT_{it}}}{\mathrm{Asset_{it}}} \tag{1}$$

$$\mathrm{Adj\_ROA_{it}} = \mathrm{ROA_{it}} - \frac{1}{n}\sum_{i=1}^{n}\mathrm{ROA_{it}} \tag{2}$$

$$\mathrm{Risk_{it}} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(\mathrm{Adj\_ROA_{it}} - \frac{1}{T}\sum_{t=1}^{T}\mathrm{Adj\_ROA_{it}}\right)^{2}} \,|\, T = 3 \tag{3}$$

4.2.2. Independent variable

This paper uses 0, 1 to indicate whether a company has a record of public green bonds issuance in the sample period (*Treat*) and whether it has issued green bonds in the corresponding year (*Time*), Finally, this paper selects the intersection of the two dummies (*DID*) as the independent variable.

4.2.3. Mechanism variable

This paper chooses the research and development expenditure (*RD_spend*) as the mechanism variable, which is measured by the amount of money invested in R&D. This indicator is measured in billions.

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4.2.4. Control variables

Due to the fact that the risk-taking level is influenced by many other factors, this paper refers to the previous study [15] and adds these variables to control: (1) size of the company (*Size*), measured by the natural logarithm of company asset; (2) financial leverage (*Lev*), calculated by dividing asset by debt; (3) ratio of the fixed asset (*Fixed*), calculated by dividing fixed asset by asset; (4) scale of board of directors (*Board*), measured by the number of directors; (5) ratio of cash asset (*Cash*), calculated by dividing cash asset by asset; (6) nature of property right (*Property*), this paper assigns 1 when company has state-owned-capital, otherwise assigns 0; (7) shareholdings of institution investor (*Ins*), measured by the percentage of shareholdings belongs to institution investors in a company. Table 1 describes of these variables:

Table 1: Summary statistics

Variable	Observation	Mean	SD	Min	Max
Risk	10095	0.037	0.044	0.000	0.340
DID	10095	0.053	0.223	0	1
Size	10095	22.830	1.376	19.308	26.388
Lev	10095	0.471	0.205	0.053	0.981
Fixed	10095	0.209	0.163	0.001	0.716
Board	10091	8.530	1.664	5	15
Cash	10095	0.140	0.107	0.008	0.664
Property	10089	0.464	0.499	0	1
Ins	10091	44.988	22.735	0.424	91.728

4.3. Model design

4.3.1. Basic regression model

Considering that the time of green bonds issuance varies among companies, this paper refers to the study of Beck [16] to construct a staggered DID model for regression. The model is:

$$Risk_{it} = \beta_0 + \beta_1 Time_{it} \times Treat_i + \sum \beta_n X_{n,it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

In this model, $Risk_{it}$ stands for the company risk-taking level, which is the dependent variable; $Time_{it} \times Treat_i$ is the independent variable, which is represented by DID_{it} in the part below; X is a series of control variables; μ_i stands for individual fixed effect, which can also be represented by i; γ_t stands for time fixed effect, which can also be represented by t; ε_{it} is the error term.

4.3.2. Mechanism effect model

R&D expenditure might be the channel through which green bonds issuance affects the company risk-taking level. This paper uses the mechanism effect model to verify it. The model is:

$$Risk_{it} = \beta_0 + \beta_1 DID_{it} + \sum \beta_n X_{n,it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (5)$$

$$RD\_spend_{it} = \alpha_0 + \alpha_1 DID_{it} + \sum \alpha_n X_{n,it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (6)$$

$$Risk_{it} = \delta_0 + \delta_1 DID_{it} + \delta_2 RD\_spend_{it} + \sum \delta_n X_{n,it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (7)$$

In this model, RD_spend_{it} stands for R&D expenditure. By observing the significance of α_1 and δ_2, the mechanism effect can be verified.

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5. Empirical analysis

5.1. Basic regression

The Table 2 demonstrates the outcome of the basic regression. After adding the control variables, individual fixed effect and time fixed effect, the coefficient is significant at the 1% level.

Table 2: Basic regression

Variable	(1) Risk	(2) Risk	(3) Risk	(4) Risk
DID	0.004**	0.004***	0.002*	0.005***
	(0.002)	(0.002)	(0.001)	(0.002)
Size		-0.016***	-0.012***	-0.014***
		(0.002)	(0.000)	(0.002)
Lev		0.031***	0.044***	0.030***
		(0.007)	(0.003)	(0.007)
Fixed		0.014*	0.000	0.018**
		(0.008)	(0.003)	(0.008)
Board		-0.001	-0.001**	-0.001**
		(0.000)	(0.000)	(0.000)
Cash		0.026***	0.006	0.027***
		(0.008)	(0.005)	(0.008)
Property		-0.009**	-0.011***	-0.008**
		(0.004)	(0.001)	(0.004)
Ins		0.000**	-0.000	0.000*
		(0.000)	(0.000)	(0.000)
Constant	0.037***	0.391***	0.295***	0.352***
	(0.000)	(0.039)	(0.009)	(0.046)
Individual Fixed Effect	Yes	Yes	No	Yes
Time Fixed Effect	Yes	No	Yes	Yes
Observation	10,095	10,088	10,089	10,088
R-squared	0.675	0.680	0.170	0.682

Note: *, **, *** demonstrate that the significance is at the level of 10%, 5%, 1% respectively. The standard error is robust.

Here is the outcome of the dependent variable. The column (4) gives the regression result of green bonds issuance on company risk-taking level. The coefficient is 0.005 and significantly positive at 1% level. This means that the issuance of green bonds can enhance company risk-taking level effectively, which verifies the hypothesis 1.

Here is the outcome of control variables. In column (4), coefficients of these control variables are different. *Size* is significantly negative, meaning that the expansion of company scale can decrease the risk-taking level. *Lev* is significantly positive, representing that leveraging can increase the risk-taking level. *Fixed* is significantly positive, demonstrating that investing more in fixed assets can increase the risk-taking level. *Board* is significantly negative, which implies that too many directors can decrease the risk-taking level. *Cash* is significantly positive, illustrating that owning sufficient cash enables companies to take more risks. *Property* is negatively significant, denoting that companies with state-owned capital may be less likely to bear risks. This is reverse of the findings of [15]. *Ins* is significantly positive, which implies that institution investors may be willing to see the increase of company risk-taking level.

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5.2. Robustness test

5.2.1. Parallel test

If the trends of treatment group and control group are not parallel before the event occurs, the difference between them after the event may be caused by other factors rather than event itself. As a result, the establishment of DID model needs to be tested by the parallel test. The Figure 1 indicates that before the issuance, there is no significant difference between the risk-taking level of treatment and control group. Their trends are parallel. After the issuance, there is a significant change, which illustrates that the DID model passes the parallel test.

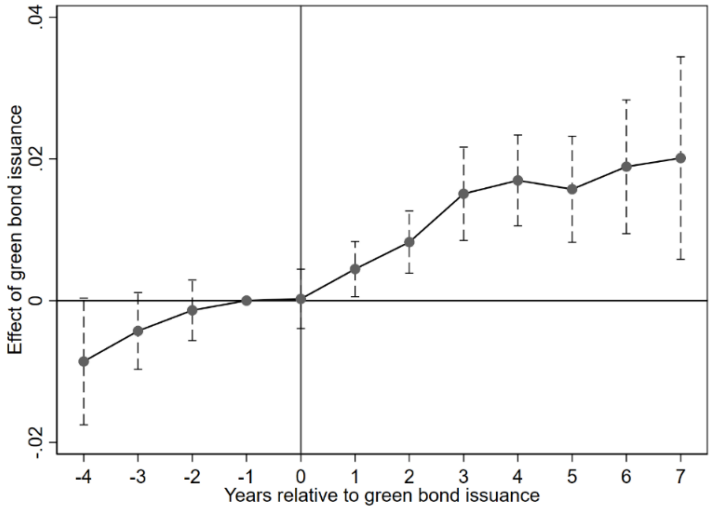

Figure 1: Parallel test

5.2.2. Placebo test

This paper adopts the method of fabricating event occurrence time to carry out a placebo test. By advancing the green bonds issuance time by three years, the *DID* is reconstructed to test the impact of green bonds issuance on the company risk-taking level. Its symbol is *DID_3*.

The results are shown in Table 4, the coefficient of *DID_3* in column (2) is not significant, which indicates that the fictitious time of green bonds issuance does not have an effect on the company risk-taking level. This proves that the model passes the placebo test.

5.2.3. Alternative risk measure

This paper tries to change the measure method of dependent variable to redo the regression. The company risk-taking level is now measured by the deviation of adjusted *ROA* in the last three years, and its symbol is *Risk_2*.

The results are shown in Table 3, the coefficient of *Risk_2* in column (3) is 0.010, which is significantly positive at 1% level. This proves that the result is robust. The issuance of green bonds does promote the risk-taking level of companies.

Table 3: Robustness test

Variable	(1) Risk	(2) Risk	(3) Risk_2
DID	0.005***		0.010***

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Table 3: (continued).

	(0.002)		(0.003)
DID_3		0.007	
		(0.004)	
Constant	0.352***	0.350***	0.678***
	(0.046)	(0.046)	(0.086)
Control Variables	Yes	Yes	Yes
Individual Fixed Effect	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes
Observation	10,088	10,088	10,088
R-squared	0.682	0.682	0.684

Note: *, **, *** demonstrate that the significance is at a level of 10%, 5%, 1% respectively. The standard error is robust.

5.3. Mechanism effect

This paper tries to explore whether R&D expenditure has a mechanism effect. To this end, the paper conducts the following regression analysis:

Table 4: Mechanism effect

Variable	(1) Risk	(2) RD_spend	(3) Risk
DID	0.005***	1.661***	0.004**
	(0.002)	(0.453)	(0.002)
RD_spend			0.000***
			(0.000)
Constant	0.333***	-56.962***	0.361***
	(0.050)	(5.132)	(0.051)
Control Variable	Yes	Yes	Yes
Individual Fixed Effect	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes
Observations	9,158	9,158	9,158
R-squared	0.683	0.956	0.683

Note: *, **, *** demonstrate that the significance is at a level of 10%, 5%, 1% respectively. The standard error is robust.

In Table 4, column (1) shows that the coefficient of green bonds issuance on the risk-taking level is 0.005, which is significantly positive at 1% level; column (3) shows that the coefficient of R&D investment on the risk-taking level is 0.000. Though this number is small, it is still significantly positive at the 1% level. Therefore, it can be assumed that there is a mechanism effect of R&D investment in the process, which verifies the hypothesis 2.

5.4. Heterogeneity analysis

The key to green transformation lies in the transformation of polluting companies. Due to the massive waste of resources and environmental pollution they have caused, polluting companies often face tougher regulations and higher transformation costs than non-polluting companies. Therefore, with the financial help from green bonds, polluting companies may be more willing to take risks to realize their own green transformation in order to get rid of the environmental penalties.

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In this paper, sample companies are divided into two types of polluting and non-polluting. The polluting companies are mainly from mining industry, manufacturing industry, energy industry and so on. This paper assigns the value of 1 to the polluting companies and the value of 0 to the non-polluting ones. To verify whether this idea is valid, this paper conducts the following analysis:

Table 5: Heterogeneity analysis

Variable	(1) Pollute=0	(2) Pollute=1
DID	0.007***	0.001
	(0.002)	(0.002)
Constant	0.326***	0.446***
	(0.056)	(0.091)
Control Variable	Yes	Yes
Individual Fixed Effect	Yes	Yes
Time Fixed Effect	Yes	Yes
Observations	6,937	3,135
R-squared	0.694	0.662

Note: *, **, *** demonstrate that the significance is at a level of 10%, 5%, 1% respectively. The standard error is robust.

Table 5 gives the results, in column (1), the coefficient of green bonds issuance by non-polluting companies is 0.007 and is significantly positive at the 1% level, while in column (2), the coefficient of green bonds issuance by polluting companies is 0.001 and is not significant.

Therefore, it can be concluded that the issuance of green bonds can significantly help non-polluting companies increase their risk-taking level, but cannot effectively increase the risk-taking level of polluting companies. For this reason, this paper argues that, on the one hand, under the strong environmental regulation, polluting companies tend to suffer larger losses by cutting off their main business that causes pollution. They can't afford to repay the green bonds. On the other hand, even though polluting companies successfully issue the green bonds, the investors might still refuse to purchase because of the companies' poor environmental reputation. The financing constraints have not been relieved. In the end, compared with non-polluting companies, polluting companies cannot fully enjoy the benefits brought by the green bonds, and the risk-taking level fails to be improved.

6. Conclusion

This paper uses the data of A-share listed companies from 2019-2023 to study the impact of green bonds issuance on company risk-taking level. The study shows that the issuance of green bonds can significantly improve the risk-taking level, and the conclusion is still valid and robust after changing the measuring method of the dependent variable. Meanwhile, the conclusion passes parallel test and placebo test. Additionally, this paper also conducts the mechanism effect analysis, which finds that green bonds can improve the risk-taking level by increasing the R&D expenditure of companies. Finally, this paper also conducts the heterogeneity analysis and finds that green bonds issuance promotes the risk-taking level of non-polluting companies better than that of polluting companies.

Actually, there are some problems which are not solved in this paper. First, in the research hypothesis, this paper assumes that both in short and long term, the green bonds can increase the risk-taking level while no empirical analysis about time has been conducted in this paper. Second, the sample period of this paper has only five years. It remains to be figure out that whether this effect still exists after expanding the sample period. Third, in this paper, the risk-taking level is measured by the volatility of ROA. This measuring method can't precisely reflect that the increase of risk-taking level is totally caused by promoting green transformation. These problems remain to be solved.

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As one of the important green financial instruments, green bonds have stimulated companies' willingness to take risks and promoted their green transformation process. These are conducive to the achievement of the "dual carbon" goals and environmental protection. By using the green bonds rationally, every country in the world can contribute to reducing the carbon emissions and protecting the environment.

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