

The Impact of Credit Rating on Pricing of Green Bond Issues - An Empirical Analysis Based on the TIC Model

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Abstract. As an important part of green finance, green bonds have become more and more obvious in the market, and their pricing has received more and more attention. As an important factor affecting bond pricing, it is necessary to explore the impact of credit rating on the pricing of green bond issues. This paper focuses on exploring the impact of credit rating on the pricing of green bond issuance by empirically analyzing the data of some green bonds issued in 2018-2022, and finds that: the credit rating of green bonds has a significant impact on their issuance interest rate, and the higher the credit rating, the lower the financing cost of green bonds; the issuance period, the issuance scale and the whether to set up the put provision and the call provision also affect the financing cost of green bond.

Keywords: Green Bonds, Credit Ratings, Issue Pricing.

1. Introduction

In recent years, with the continuous development of China's economy, and the accompanying environmental problems have become more and more serious. With the rise and development of related concepts, China's green financial system has been gradually established. Green bonds, as an important part of the green financial system, play an important role in the development of green industry, therefore, to explore the impact of green bond pricing factors has become an urgent problem to be solved. Credit rating can play the role of credit enhancement for the rated bonds, reduce the financing cost of the issuer, weaken the information asymmetry between the issuer and the investor, which is of great significance to the long-term development of the green bond market.

The research mainly focuses on:

(1) Research on the concept of green finance and green bonds

At present, the academic community has not yet reached a consensus on the definition of green finance, scholars' definition of the concept of green finance mostly draws on documents issued by various authoritative organizations. For example, in 2016, the Guiding Opinions on the Construction of a Green Financial System talked about green finance as an economic and financial activity conducive to the improvement of the environment and the enhancement of the utilization rate of resources' economic and financial activities [1].

The international identification of green bonds mainly includes the Green Bond Principles and the Climate Bond Standard. The Green Bond Principles set out four elements that green bonds should have covering the assessment of fund-raising projects, fund-raising programs, fund-raising management and information disclosure. The Climate Bond Standard strictly restricts the industries to which green bonds belong, and the types of green projects it recognizes are clean energy, low-carbon, water, agriculture. At present, the main Chinese documents defining green projects are the Green Bond Issuance Guidelines and the Catalog of Green Bond Supported Projects. They respectively specify 12 types of supported green projects and 6 major categories and 31 subcategories of projects with significant environmental benefits [2].

(2) Research on Green Bond Pricing

Scholars for green bond pricing research generally formed the following views: green bond yields are significantly higher than ordinary bonds, this effect is more significant for bonds with a third-party green certification [3]; the market interest rate, GDP quarterly growth rate and CPI are

significantly positively correlated with the green bond issuance rate, enterprise assets, enterprise asset-liability ratio and the issuer's credit rating are significantly negatively correlated with the green bond issuance rate [4-5]; China's green bond market exists in many aspects challenge, including the phenomenon of greenwashing, the issuer is not highly motivated and other issues [6].

(3) Research on credit ratings affecting bond pricing

With regard to the credit rating impact on bond pricing, scholars' research is more comprehensive, in terms of the necessity of credit rating on bonds, scholars generally believe there is an information asymmetry between bond issuers and investors, while investors do not have the ability to take the initiative to conduct a separate investigation of the company. Therefore, it is necessary for the issuer to commission a rating agency to issue a rating report after an independent investigation of the issuer. The rating results can clearly reflect the risk of the enterprise, provide reference for the regulator [7-8]. In the research on the impact mechanism of credit rating on bond pricing: it is found that the rating opinion of agencies can react to the level of enterprise risk and the cost of bond financing, the higher the rating level, the lower the cost of financing[9-11].

In summary, at present, there have been a number of scholars for credit rating on bond issue pricing research, but most of the researchs are focused on general corporate bonds, specifically discussing the green bonds and credit rating literature is less, and about the green bonds, green bond pricing and credit rating of the three, most of the existing literature only discusses the impact of the relationship between the two sides. Therefore, based on summarizing the research methods and conclusions of previous scholars, this paper investigates the impact of credit ratings on green bond issue spreads, which is conducive to enriching the relevant literature on the impact of credit ratings on green bond pricing in China, providing information for the decision-making of green bond investors and issuers, and promoting the healthy development of the green bond market.

2. Relevant Concepts and Theoretical Foundations

2.1. Concept, types and characteristics of green bonds

"Green bond" means a bond instrument in which the proceeds are used exclusively to finance or refinance green projects that meet prescribed conditions. Compared with ordinary bonds, green bonds have five characteristics: special use of funds, specific identification criteria, relatively long issuance period, strict disclosure requirements, and government support. Green bonds according to the issuer and the issuance of different places can be divided into green financial bonds, green corporate bonds, green enterprise bonds, green asset-backed securities and non-financial enterprises green debt financing tools five categories, which is the most widely issued green financial bonds.

2.2. Concept and Functional Role of Credit Rating

(1) The concept of credit rating

Credit rating, refers to the comprehensive evaluation of the credit risk factors of economic entities and debt financing instruments by credit rating agencies on the principles of independence, objectivity and impartiality, and is expressed by rating symbols. China's credit rating is divided into "three levels and nine grades", including AAA, AA, A, BBB, BB, B, CCC, CC and C.

(2) Impact of credit rating on the pricing of green bond issuance

In the bond market, the credit rating of general bonds is scored by a specialist credit assessment agency after the comprehensive evaluation of the bond issuer's debt repayment ability and its own creditworthiness. To a certain extent, it can reflect the risk level of the bond and whether it can repay the principal and interest on time. The purpose of rating bonds is to reduce the cost of credit for those who invest in the bond market. The rating scheme obtained from the bond rating is also easy for investors to learn from.

Compared with general bonds, green bonds are a financial tool to meet the financing needs of green projects, most of which are characterised by long project payback periods and low returns. Therefore, the requirements for issuers are higher, such as requiring high repayment ability and better

quality guarantees. Credit rating, as an effective way to solve the information asymmetry between investors and financiers, is of more significance in the green bond market.

2.3. Relevant theories

(1) Information asymmetry theory

Information asymmetry is that all parties involved in the market do not have the same information, and tend to make different judgements based on the information they have obtained, and the part of the information more fully grasp the more favourable position will be occupied in most cases. Generally speaking, in order to be able to close the deal at the desired price, the seller always tends to promote the good side of the product, while the bad side is glossed over or hidden, so the seller is generally the one who has more information, and the buyer will be under pressure to seek more information or to avoid entering into a transaction.

This is often the case in bond markets, where bond issuers tend to have more comprehensive, detailed and truthful information than bond investors. Investors in an information disadvantageous position often need to pay a larger cost of information and monitoring costs, which is also more likely to lead to adverse selection and moral hazard. Green bonds as a new type of bonds, the issuer of the bonds invested in the green industry may not be known to the public, so this makes some issuers in the name of issuing green bonds to issue bonds, but in reality is to raise funds to invest in other projects, the phenomenon of "Greenwashing", which may damage the interests of investors.

(2) Transaction Cost Theory

Transaction cost theory suggests that the reason why there are enterprises, because some transactions through the market mechanism to complete the cost is very high, this cost is called transaction costs.

In the bond market, due to the information asymmetry between buyers and sellers, investors to protect their own interests are bound to do their best to collect the relevant information of the bond issuing enterprises, which will undoubtedly produce huge transaction costs, and credit rating agencies as an objective intermediary institutions on the issuer and the issuance of bonds for credit ratings, effectively reduce the information asymmetry and professional knowledge and skills brought about by the limitations of the transaction costs, thereby reducing the risk return rate required by investors for this part of the risk, which in turn reduces the issuer's financing costs.

Therefore, the construction of a perfect credit rating system can effectively reduce the transaction costs due to information asymmetry and professional knowledge and skill limitations, thus reducing the risk of investors this part of the risk required, and thus reducing the financing costs of the issuer.

(3) Signal transmission theory

Signal transmission theory is a powerful tool to solve information asymmetry. The signaling theory argues that due to the existence of information asymmetry, high-quality enterprises will transmit favourable corporate information to the market, and in this way attract more investors.

In the bond market, a high-quality company is more inclined to take the initiative to disclose its debt-servicing ability and profitability to the credit rating agencies in order to show the company's favourable financial and operating conditions, and to transmit such news to investors in a timely manner through credit ratings for the ultimate purpose of financing. Whereas a company with a poor credit rating is considered to have poor performance and a higher risk of default, therefore, the business risk of enterprises increases, and the demand for financing increases. In order to obtain more financing concessions, enterprises are more willing to take the initiative to actively transmit their high-quality information to the credit rating agencies to show the company's good financial condition and operating conditions, which helps the credit rating agencies and comprehensively assess the default risk of enterprises and helps investors make the most correct invest decision.

3. Research design

3.1. Data selection

This paper selects the green bonds issued during 2018-2022 as the research sample, the data from Choice Financial Library, Cathay Pacific Database, China Bond Information Network, the sample contains green financial bonds, green short-term financing bills, green medium-term notes, green directional instruments, green asset-backed securities, green corporate bonds and green corporate bonds. The sample includes some bonds lack debt ratings or main ratings, 720 bonds are obtained after screening.

3.2. Definition of Variables

The definition of variable as shown in Table.1.

Table.1. Variable definitions and descriptions

Type	Name	Symbol	Remarks
Explained variable	Issue spread	TIC	Green bond issuance rate minus Treasury bond issuance rate of the same maturity on the day of green bond issuance.
	Debt rating	BR	A+, AA-, AA, AA+, AAA 1, 2, 3, 4, 5 respectively.
Explanatory variables	Subject rating	IR	A+, AA-, AA, AA+, AAA 1, 2, 3, 4, 5 respectively.
	Issue Size	LNSIZE	Natural logarithm of bond issue size
Control variables	Issue Term	LNTERM	Natural logarithm of bond issue term.
	Put provision	PUT	Dummy variable,1 if the bond is puttable, 0 otherwise.
	Call provision	CALL	Dummy variable,1 if the bond is callable, 0 otherwise.
	Bond market index	INX	SSE Green Bond Index on the date of bond issuance.

3.2.1 Explained Variables

Issue spread: This paper obtains the treasury bond issuance rate through Choice Financial Library, and subtracts the green bond issuance rate from the treasury bond issuance rate of the same maturity on the day of issuance to obtain the green bond issuance spread. If there is no matching treasury bond issuance rate on the day of green bond issuance, the data of the most recent date is used. If the green bond issuance period is not an integer year, the data of the nearest integer issuance period is used.

3.2.2 Explanatory Variables

Debt rating: The higher the debt rating represents the lower the risk of bond default, which can reduce the issuance cost to a certain extent, and is negatively related to the issuance spread.

Subject rating: The higher main rating represents the better qualification of the company, which can reduce the issuance cost to a certain extent, and is negatively related to the issuance spread.

3.2.3 Control Variables

(1) **Issue Size and Issue Term:** The larger the issue size, the more the issuer's economic strength is initially demonstrated, the investor will prejudge the issuer's anti-risk ability, and at the same time, the issue size has an impact on the liquidity of the bond; based on the theory of asymmetric information, the growth of the issue term, the more the information related to the bond can be obtained, which also affects bond liquidity, and the relationship with the interest rate shows negative correlation.

(2) Put provision and Call provision: as the two conditions attached to green bonds, although they have not been popularized to all bonds, they are equivalent to insuring the bonds, and naturally have an impact on bond interest rates.

(3) Bond market index: bond market index is a digital form to reflect the overall price trend of bonds, if the bond market index the higher, the higher the overall price of bonds will also be higher, it is necessary to provide higher yields to attract investors, the bond market index and the cost of issuance of the market shows a positive correlation, this paper uses the SSE green bond index

3.3. The establishment and selection of model

Through the collation of literature, the common models used in the previous research on bond issue spread and its influencing factors are "NIC model", "IFR model" and "TIC model". The main difference lies in the explanatory variables, the IFR model and TIC model use the real interest cost, while the NIC model uses the net interest cost, which can only be compared in bonds with the same issuance method.

The above three models are mostly multiple linear regression models, and the left side of the specific equation is usually the explained quantity, which can be either the bond issuance rate or the bond issuance spread. On the right side are all kinds of explanatory variables and control variables with coefficients, such as bond maturity, bond size, etc., and at the same time, the right side also needs to add a kind of random error term. When dealing with some data that are not direct values, the form of assignment can be used, for example, the bond's debt rating and the subject rating is displayed in alphabetical symbols, according to the size of the grade can be assigned to the corresponding value, this operation will be more convenient to carry out regression analyses.

Taking into account the characteristics of the research sample and the research purpose of this paper, this paper uses the TIC model and makes certain improvements in the selection of model variables, using OLS regression to examine the impact of credit rating on green bond issuance spreads, and the design model is as follows:

$$TIC = \beta_1 IR + \beta_2 BR + \beta_3 LNSIZE + \beta_4 LNTERM + \beta_5 PUT + \beta_6 CALL + \beta_7 INX + \varepsilon$$

Where β denotes the coefficients of each variable and ε denotes the random error term.

4. Results

4.1. Descriptive Analysis

Descriptive statistical analysis of the various data of the 720 samples, as shown in Table2.

Table.2.Descriptive analysis results

Name	Symbol	minimum	maximum	mean value	standard deviation
Issue spread	TCL	-1.8400	6.0400	1.5632	1.1391
Issue Term	LNTERM	-0.0202	3.4012	1.6028	0.5350
Issue Size	LNSIZE	-1.5606	5.7038	2.1049	1.0648
Debt rating	BR	1	5	4.55	0.841
Subject rating	IR	1	5	4.22	1.121
Put provision	PUT	0	1	0.38	0.369
Call provision	CALL	0	1	0.16	0.478
Bond market index	INX	99.45	131.44	121.0009	7.7623

The mean value of TIC is 1.5632, the standard deviation is 1.1391, the maximum value is 6.0400, the minimum value is -1.8400, and the extreme deviation is 7.8800, which indicates that the extreme values of the issue spreads of the green bonds are more varied, but the overall difference in the spreads is smaller. LNTERM's mean value is 3.4012, the green bond term setting is more flexible, the maximum value of the issuance term in the sample is 30 years, and the minimum value is 0.98 years,

but most of them are concentrated in 5 years. LNSIZE’s mean value is 5.7038, due to the strength of each issuance body is different, resulting in the issuance of the bond scale between the larger differences in the sample in the largest issue size is 30 billion and the minimum size is 20 million. The mean value of the debt rating and the subject rating is 4.55 and 4.22 respectively, and the standard deviation of the debt rating is 0.841, which is smaller than the standard deviation of the subject rating of 1.121, indicating that the difference of the main rating is higher than that of the debt rating. The mean values of the two additional terms of the debt, PUT and CALL, are 0.38 and 0.16 respectively, indicating that more bonds do not have special terms. The average value of INX is 121.00, the maximum value is 131.44, the minimum value is 99.45, and the data fluctuates greatly.

4.2. Correlation test

As shown in Table.3, the correlation between TIC and BR and IR is -0.501 and -0.586 respectively, indicating that the debt rating, subject rating and the issuance spread of green bonds present a negative correlation; the correlation between LNTERM and TIC is 0.245, indicating that the issuance period is positively correlated with the issuance spread, and the longer the issuance period is, the larger the issuance spread is; The correlation between LNSIZE and TIC is -0.405, indicating that there is a negative correlation between the issue size and the issue spread, and the larger the issue size of the bond, the smaller the issue spread; the two additional terms of the bond PUT, CALL and the issue spread TIC are positively correlated, indicating that the setting of the resalable and redeemable terms will increase the green bond The correlation result between bond market index INX and TIC is -0.283, which is negatively correlated, indicating that the higher the bond market index is, the smaller the issuance spread is.

Table.3. Correlation test results

Name	BR	IR	LNTERM	LNSIZE	PUT	CALL	INX
TIC Pearson correlation coefficient	-0.501**	-0.586**	0.245**	-0.405**	0.236**	0.113**	-0.283**
TIC Sig.(Double tails)	0.000	0.000	0.000	0.000	0.000	0.002	0.000

4.3. Analysis of linear regression results

Regression of the sample data by OLS obtained the results shown in Table.4

Table.4.Regression results

Name	Standardized coefficient	Significance
BR	-0.161	0.000
IR	-0.405	0.000
LNTERM	0.083	0.005
LNSIZE	-0.215	0.000
PUT	0.072	0.004
CALL	0.099	0.002
INX	-0.215	0.000

It can be found in the results of the above regression analysis that the standardized regression coefficients of the debt rating and the subject rating of the green bonds are -0.161 and -0.405 respectively, which indicates that the debt rating and the subject rating have a significant negative correlation with the spread of the issue, and from the values obtained in the analysis it is seen that for every 1% increase in the debt rating scores, there is a reduction of the spread of interest rates by 0.161%;for every 1% increase in the subject rating score, there is a 0.405% decrease in the interest rate spread.The regression coefficient of LNSIZE is -0.215 indicating that there is a significant negative correlation between the issuance size of green bonds and issuance spreads, the larger the issuance gauge of green bonds, the smaller the issuance spreads, and when the issuance size is increased by 1%, the issuance spreads of green bonds decrease by 0.215%. The LNTERM of issuance

term is 0.083, which indicates that there is a significant positive correlation between issuance term and the issuance spread of green bonds, and when the term is increased by 1%, the issuance spread rises by 0.083%. The regression coefficients of PUT and CALL are both positive, investors face the risk of interest rate increase before the put back date, and benefit after the exercise of the right, while the put provision is significantly positive in the regression results, indicating that setting up the put provision can improve the issuance spreads, compared with the put provision, the regression coefficient of the call provision is larger, and the results are more significant, which has a greater impact on the green bond issuance spreads. Bond index and green bond issuance spreads are significantly negatively correlated, as the higher the index, the higher the overall price of the bond, the issuance of bonds in this market will need to give higher yields to attract investors, leading to the flow of funds to the green bond market.

4.4. Robustness test

In the robustness test, the difference between the issuance rate of the sample bonds and the issuance rate of the 5-year treasury bonds is used as the issuance spread, and the results shown in Tables.5 are obtained, where the coefficients of the explanatory variables have the same sign and the same significance as those of the original model, proving that the model regression is robust.

Table.5.Robustness test results

Name	Standardized coefficient	Significance
BR	-0.160	0.000
IR	-0.394	0.000
LNTerm	0.190	0.005
LNSIZE	-0.165	0.000
PUT	0.089	0.002
CALL	0.070	0.009
INX	-0.242	0.000

5. Conclusions

5.1. Research Conclusion

After regression analysis of the 720 green bonds in the sample, it is confirmed that credit ratings can significantly reduce the financing cost of green bonds, and compared with green bonds with low credit rating scores, the interest rate of high-scoring green bonds is significantly lower at the time of issuance; the debt rating and the subject rating have different impacts on the issuance spreads of green bonds, and overall, the main subject ratings have a greater impact than the debt ratings. In the descriptive analysis, the mean values of debt rating and subject rating are 4.55 and 4.22 respectively, which represents that the average rating of green bonds has reached AA+, indicating that the default risk of green bonds is small and suitable for investors to choose investment. In addition, the scale of bond issuance and issuance term will have a significant impact on the issuance spread of green bonds, the longer the issuance term, the larger the issuance spread of green bonds; the larger the issuance scale, the smaller the issuance spread of green bonds. Although not all bonds have the put provision and the call provision, the existence of these two factors will increase the issuance spread of green bonds.

5.2. Recommendations

(1)For issuing enterprises, pay more attention to and improve credit rating

In the preliminary selection of data, there are still some green bonds are missing credit rating results, which shows that the issuers of these green bonds do not pay attention to the role of credit rating. Credit rating can significantly reduce the financing cost of green bonds, and the level of credit

rating largely affects the interest rate of bond issuance. Therefore, enterprises issuing green bonds should pay more attention to the improvement of credit rating.

(2) Further unify and standardize rating standards

At present, there are still differences in the rating quality and standards of different rating agencies, the credit rating of green bonds from the distribution point of view of the vast majority of the concentration in the "AAA" grade, this status does not reflect the differentiation of credit ratings. In this regard, the government should regulate the third-party certification bodies and rating agencies, and commit to making them more professional, so as to lay the foundation for the rapid development and maturity of the green bond market; meanwhile, it should also issue corresponding policies in a timely manner, and supervise and regulate the rating agencies and certification bodies, so as to prevent the phenomenon of regulatory evasion, protect the rights and interests of investors, and safeguard the healthy development of the financial market for a long time.

(3) Improve the regulatory system of green bond issuance and increase the publicity of green bonds.

With the continuous development and expansion of China's green bond market, the management of the green bond market will gradually appear a variety of problems, therefore, the government should continue to improve the relevant mechanisms, strengthen the encouragement of green bonds to guide the establishment of a complete bond market. At the same time, the relevant institutions should increase the publicity and education work on green bonds, improve the visibility of green bonds, and further promote the development of green industry.

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