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The Interest Costs of Green Bonds: Credit Ratings, Corporate Social Responsibility, and Certification

Zhiyong Li[1,2], Ying Tang[1], Jingya Wu[1], Junfeng Zhang[1], and Qi Lv[1]

[1]*School of Finance, Southwestern University of Finance and Economics, Chengdu, China;*
[2]*Collaborative Innovation Center of Financial Security, Southwestern University of Finance and Economics, Chengdu, China*

ABSTRACT: In recent years, green financing has attracted global attention. Many countries and international organizations have proposed frameworks for developing green financing, and an increasing number of companies issue green bonds as financial instruments for funding green projects. Unlike conventional bonds, green bonds have unique features, and their issuance follows a special process. We use data on Chinese green bonds in a linear regression model to empirically explore the impact of credit ratings, corporate social responsibility (CSR), and green certification on yield spreads. The results show that these factors all have a significant impact on interest costs. Issuing green bonds is a signal of CSR, and green bonds with green certificates have lower interest costs than those without them. Finally, we outline some policy implications regarding the governance of green bonds based on our findings.

KEY WORDS: certification, corporate social responsibility, credit rating, green bonds, interest costs

Rising concerns related to environmental issues demands increased attention to climate change, highlighting the urgency of developing green financing and the need for investment in green projects. As a major green financing instrument, green bonds have introduced a new wave of development. Since the World Bank issued the first green bond in 2008, the global market for these bonds has grown rapidly. At the same time, many countries and organizations have implemented various definitions and criteria for green bonds without a globally recognized standard. Since 2014, the International Capital Market Association has published Green Bond Principles (GBP) and updated it annually (ICMA, 2017). The GBP are the first voluntary guidelines for green bonds that are widely accepted by market stakeholders. According to the GBP, green bonds are any type of bond instrument whose proceeds are applied exclusively to financing or refinancing, in part or in full, new, or existing eligible green projects and those that are aligned with the four core components regarding the use of the proceeds, the process of project evaluation and selection, management of the proceeds, and reporting on the use of the proceeds. Although green bonds have many characteristics in common with conventional bonds, they have some unique features, such as voluntary green bond certification as well as relatively longer terms than conventional bonds, because the payback from investment in green projects takes longer. In addition to the ICMA, other international organizations and financial institutions, such as Barclays (Preclaw and Bakshi 2015) and the Climate Bonds Initiative (CBI, 2016), have also published research reports on the worldwide development of green bonds.

In recent years, many countries have issued green bonds. As of June 2018, the CBI database[1] listed a total of 3,257 green bonds with an average maturity of 10.4 years. A rapid increase is obvious in both the yearly number and cumulative value in recent years (Figure 1). The total value in 2017 increased by 84.7% over that in 2016. Figure 2 shows that the United States dominates the global green bond market,

Address correspondence to Ying Tang, School of Finance, 555 Liutai Avenue, Wenjiang, Chengdu, Sichuan, China. E-mail: zhongnanty@126.com
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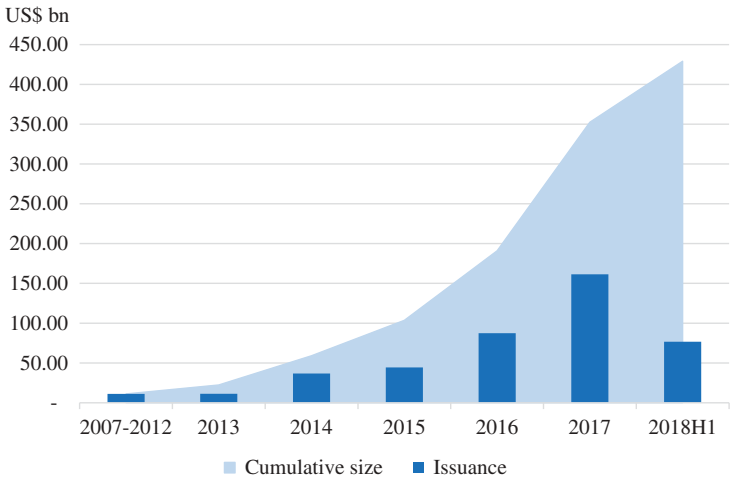

Figure 1. Yearly and cumulative value of green bonds.
Source: Climate Bonds Initiative green bonds database.

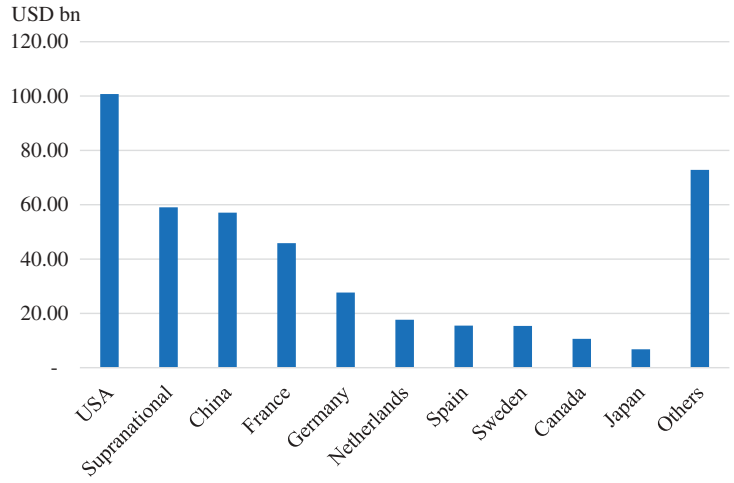

Figure 2. Number of green bonds issued, by country.
Source: Climate Bonds Initiative green bond database.

holding a 23.47% share of the worldwide total. The total value of green bonds issued in China is about US $57.1 billion, which is about 13.3% of the worldwide total, ranking second in the world exclusive of international agencies (World Bank, etc.). Other countries in the top 10 include France, Germany, the Netherlands, Spain, Sweden, Canada, and Japan.

The only emerging economy in this group, China has been particularly active in promoting the development of green bonds in the past few years, including implementing policies and offering guidance, which has contributed to its rapid growth since 2014. This research on the Chinese green bond market thus provides valuable implications for other countries, especially emerging economies.

Although the green bonds market is growing rapidly, scholarly attention has been rather limited, with few empirical studies. Flaherty et al. (2017), for example, used a three-stage model to prove the necessity and rationality of green bonds, finding that they help tackling greenhouse gas emissions because they are repaid and reissued within a finite horizon. Other studies mainly provide basic

descriptive statistics. Preclaw and Bakshi (2015) deconstruct the cost of issuing green bonds into common risk factors and an indicator of "greenness" in a regression model on the option-adjusted credit spread. Zerbib (2017) finds that on average a negative yield premium exists between a green bond and an equivalent synthetic conventional bond, expressed as a percentage of the conventional bond yield.

This article is the first to empirically study the interest costs of green bonds. Because environmental and climate issues are involved, the determinants of interest costs for green bonds may differ from those of conventional bonds. It is important to examine the factors that influence interest costs and the mechanisms that facilitate accurately pricing of the underlying assets. We empirically investigate the effects of credit ratings, corporate social responsibility (CSR), and green certification on the interest costs of green bonds. Our research, therefore, adds to the very small corpus of literature on green bonds and highlights the importance of green bond regulations.

The remainder of this article is organized as follows: Section 2 reviews the literature on aspects related to green bonds. In Section 3, we develop hypotheses to be tested, introduce our model settings, and summarize the variables to be analyzed. Section 4 gives our sample selection and descriptive statistics. In Section 5, we present the results of our empirical analysis. Finally, Section 6 concludes the article with policy suggestions.

1. Literature Review

Studies on conventional bonds discuss many ways to measure bonds' interest costs. Sorensen (1979) uses true interest costs as the measurement to illustrate the impact of the underwriting method and bidder competition on corporate bond interest costs. Kisgen and Strahan (2010) define the yield on a corporate bond for the indicated month, minus its yield in January 2003 (the month prior to the Dominion Bond Rating Service to obtain Nationally Recognized Statistical Ratings Organizations status) as the dependent variable, to investigate how firms' credit rating affects bond yields. Jiang (2008) uses two proxies, credit rating and initial bond yield spread, to represent a firm's cost of debt and analyzes the relationship between earnings' beating the benchmarks and their cost of debt.

The bond yield spread is defined as the bond yield to maturity at the issue date minus the Treasury yields with comparable maturity, often used an indication of the risk premium that firms or financial institutions must pay to borrow money in the bond market. It can be used to proxy for a firm's or financial institution's cost of debt financing (Ağca and Celasun 2012; Jiang 2008; Liu and Magnan 2016; Sengupta 1998; Shi 2003). This measure has been widely used in other articles to capture the ex-ante cost of debt (Bhojraj and Sengupta, 2003; Jiang 2008; Liu and Jiraporn 2010; Mansi, Maxwell, and Wald 2009; Ortiz-Molina 2006). In this article, we specifically observe credit ratings, CSR, and green certification. Because all these factors are determined before the bonds are issued, the ex-ante yield spread measure is appropriate for our study. Therefore, bond yield spread is used to measure the interest cost of green bonds.

The credit rating represents a credit rating agency's evaluation of the prospective debtor's intrinsic creditworthiness (Guzman and Moldogaziev 2012) and can implicitly forecast the likelihood of default by the debtor. The credit rating is critical for bonds as it affects bond issuers' access to bank loans, bonds, and commercial paper markets (Jiang 2008). It is intuitive that credit ratings have an effect on bond yields. Ziebart and Reiter (1992) find that the bond rating affects bond yields directly, and financial information affects bond yields indirectly through its effect on bond ratings. He and Jin (2010) suggest that although the debt rating and corporate rating both have an impact on bond yields, of the two, the debt rating matters more. Credit rating agencies have access not only to firms' public information but also to non-public information gathered as result of their due diligence (Liu and Jiraporn 2010); thus, credit ratings actually integrate rich information and play important roles in the bond market. Steiner and Heinke (2001) examine the daily excess returns of Eurobonds due to the impact of announcements of Standard &

Poor's and Moody's credit reports. This announcement effect is significant for downgrading and negative watch-listing announcements, but not significant for upgrading and positive watch listings.

As green bonds are intended for green projects that address environmental issues, they are naturally linked to CSR, which is addressed in a regulation by the China Securities Regulatory Commission (CSRC; 2017). CSR is an essential component for firms with environmental concerns. McWilliams and Siegel (2001) define CSR as actions that appear to advance a social good beyond the interests of the firm and that which is legally required. Obviously, CSR is closely related to the public interest, of which environmental protection is an important part. A connotation of environmental conservation links CSR closely to green bonds, which likewise regard environmental protection as their core principle. Beyond sharing similar concerns about environmental protection, CSR has a potential impact on the cost of green bonds.

According to Freeman's (1984) shareholder theory, corporations should go beyond the interests of their shareholders and take the benefits of a broader group into account: communities and individuals who are able to influence or be influenced by their activities. Follow-up studies further expand the theory and investigate the commercial value of CSR, giving insight into the competitive advantages of acquiring integral resources and stakeholders' support (Jones 1995) for the firm. McWilliams and Siegel (2001) also suggest that CSR investments contribute to the shaping of a good social image, hence a reasonable amount of investment in philanthropy and social activities is significant for the sake of profits. Previous studies (e.g., Garriga and Melé 2004; Jones 1995) provide a theoretical basis for the fact that better CSR performance can bring firms potential financial benefits, which reduce their operational risk and credit risk and thus lower the cost of financing.

A few studies indicate that higher overall CSR performance scores have statistical relevance to lower bond yield spreads (Ge and Liu 2015; Oikonomou, Brooks, and Pavelin 2014). Dhaliwal et al. (2011) investigate the relation between potential reduction in the cost of equity capital and the initiation of voluntary disclosure of CSR activities and conclude that superior CSR performance leads to a conspicuous reduction in the cost of equity capital. Similarly, El Ghoul et al. (2011) find that firms with better CSR performance score generally have lower ex-ante equity costs. Different views also exist that firms with preferable CSR performance scores are charged of higher loan costs by banks because they regard CSR concerns as risks and hence respond with less attractive loan contract terms (Goss and Roberts 2011).

Certified green bonds are bonds whose proceeds are earmarked for financing new and existing projects that have specific environmental benefits. Thus, a green bond certificate is a signaling or discovery mechanism for investors, which enables the identification of climate-aligned investments with limited resources needing to be spent on due diligence. In this way, certifying a bond as green reduces friction in the market, thereby facilitating growth in climate-aligned investments (Climate Bonds Initiative (CBI) 2016). The CBI provides sector-specific green definitions developed by scientists and industry experts, which are available to the public guide on the CBI website.[2] Issuers who want to have their green bonds certified must arrange for independent reviews under the Climate Bonds Standard to be conducted by CBI-approved examiners (CBI, 2018). The standard sets out the requirements for climate bond certification. The requirements are divided into pre- and post-issuance requirements for both initial and continuous certification. To date, the CBI has 34 approved verifiers.

In China, green bonds issued in the interbank bond market should follow guidelines laid down by the People's Bank of China (PBOC, 2015) regarding issuer qualifications, related materials, and certification agencies. According to the guidelines, the issuer must disclose special audit reports in addition to annual reports on the use of the funds raised the previous fiscal year. The PBOC monitors the use of funds raised by green financial bonds and regularly publishes statistical results. In addition, the PBOC and CSRC (2017) provide an official standard on green bond certification in China and encourage issuers to obtain third-party certification approved by professional associations.

The literature outlines other factors that explain the bond yield spread, generally divided into issuing characteristics and macroeconomic factors. Issuing characteristics include the scale, bond maturity, bond-issuing location, and the purpose of the bond issuance. The scale of issuance can be used as a proxy for

external liquidity (Chen, Liao, and Kuo 2013). In terms of the economic scale, a larger issuance tends to result in a narrower spread (Sorensen 1979) but increases pressure in the bond market (He and Jin 2010). Generally, the yield spread term structure slopes upward (Chen, Liao, and Kuo 2013), therefore longer maturity is associated with a higher yield because of the increased exposure to interest rate risk (Ziebart and Reiter 1992). As for the bond issue location, the interbank market is a wholesale market and requires relatively lower yields, whereas exchanges take place in the retail bond market, which requires higher yields (He and Jin 2010). Guzman and Moldogaziev (2012) find that the purpose for which the debt was issued can also affect its cost, with bond purposes traditionally considered riskier and thus carrying higher borrowing costs. Jaffee (1975) shows that risk premiums can vary with the business cycle. Because the sample period of this study spans several years, it is necessary to control for macroeconomic factors. Guzman and Moldogaziev (2012) introduce a variable for volatility in their study of bond cost differentials to control for market volatility, defined as the standard deviation of the 8-week moving average of the Bond Buyer 20 index (the average market yields of municipal bonds with a final maturity of 20 years). Volatility reflects the bond issuance environment and the stability of the bond market. The more volatility there is in the market, the greater the risk to investors, thus the higher the rate of return they require (He and Jin 2010).

This research makes three contributions to the existing literature. First, it provides the first empirical evidence on the determinants of the interest costs of green bonds. Second, it is focused on CSR, as it is closely related to requirements of green bonds that have not been sufficiently addressed, even in conventional bond studies. Third, we investigate green bond certification as a special process that brings both benefits and costs to bond issuers and is believed to have an impact on the pricing of green bonds. Thus, our results provide insights for regulators from the Chinese experience, as well as international implications when green bonds expand dramatically worldwide.

2. Research Design

2.1. Hypothesis

It is suggested in the literature that credit ratings play a significant role in bond yields, as credit ratings convey reliable information about the quality of bonds, as well as bond issuers. Sorensen (1979) provides evidence that bonds with lower ratings have higher re-offering yields and are often associated with a wider spread due to higher underwriting costs. Similarly, Peng (2002) finds that the borrowing cost of insured municipal bonds can be reduced by 4 basis points (bps) with a Standard & Poor's underlying rating. Hsueh and Kidwell (1988) suggest that bonds with credit ratings from two rating agencies, regardless of whether the rating results are the same or different, can help to reduce borrowing costs, because the second rating provides additional information. Credit ratings usually act as an evaluation of potential default risk for conventional bonds, but credit ratings of green bonds can also provide additional information on the "greenness" of the projects funded, as well as issuers' environmental costs. Some credit rating agencies are also the approved verifiers of green bonds. Therefore, we hypothesize that a higher credit rating is associated with a lower bond yield spread and form the following hypothesis to be tested:

Hypothesis 1. *Ceteris paribus, the credit rating of green bonds is negatively related to their yield spread.*

Some literature posits that companies are more likely to have good overall performance if they pay enough attention to sustainability and social responsibility. Goss and Roberts (2007) find that firms with the lowest social responsibility scores can have a spread of 16 bps, but firms with average or higher scores can benefit only a little from increasing the score further. Ge and Liu (2015) argue that firms with good CSR performance can issue bonds at a lower cost. Gong, Xu, and Gong (2018) find that in China, firms with higher CSR disclosure quality have lower costs for corporate bonds, and this negative relationship is more significant at firms that have weak corporate governance or are in a weak institutional environment. Thus, our intuition is that firms can benefit from better CSR performance in their bonds. This leads us to form our second hypothesis:

Hypothesis 2. *Ceteris paribus, better CSR performance by a firm is negatively related to the yield spread of green bonds.*

Because of information asymmetry, it is difficult for bond investors to obtain complete information on the use of funds raised by issuing bonds without due diligence. The certification of green bonds can provide investors with valuable information, which ensures that funds are earmarked for financing green projects and ensuring environmental benefits, as indicated by Oliver (2013). Thus, a green bond certificate could act as a signal for investment. It helps investors identify climate-oriented investments using limited information. In this way, a green bond certificate can reduce friction in the market and thus contributes to a lower interest cost of green bonds and facilitates growth in climate-oriented investments. This mechanism is similar in a way to insurance on municipal bonds, which helps alleviate information asymmetry in the market. This reasoning is captured in our third hypothesis:

Hypothesis 3. *Ceteris paribus, bonds labeled as green are positively related to lower yield spreads.*

2.2. Empirical Models

To test the three hypotheses, we construct a model to examine the determinants of the green bond yield spread:

$$\begin{aligned} Spread = {} & \beta_0 + \beta_1 Label + \beta_2 CSR + \beta_3 IR + \beta_4 BR \\ & + \beta_5 \ln(Maturity) + \beta_6 TypeEN + \beta_7 TypeFI \\ & + \beta_8 Index + \beta_9 ROE + \beta_{10} EI + \beta_{11} FAT + \varepsilon \end{aligned}$$

In this model, the dependent variable is the initial yield spread, which measures the risk premium that a firm must pay for issuing a green bond and can be regarded as a measure of green bond interest costs. Our main concerns in this model are green bond certification (*Label*), CSR performance, and bond issuer rating (*IR*). Apart from these three test variables, based on previous research (e.g., Gong, Xu, and Gong 2018; Liu and Jiraporn 2010), we also introduce several firm levels, bond levels, and macro control variables to this model.

2.3. Variables

Spread: Bond yield spread (in percentage). According to previous studies (Ağca and Celasun 2012; Jiang 2008; Liu and Magnan 2016; Sengupta 1998; Shi 2003), the bond yield spread is calculated as the bond's yield to maturity on the issue date minus the yield to maturity of a coupon Treasury bond with identical maturity during the same year.

Label: The variable for green bond certification. It takes a value of 1 for certified green bonds and 0 for uncertified bonds. We obtained the verifier's name from the database to ensure whether the bond is certified.

CSR: The CSR score is constrained by the availability of data. Bond issuers are not necessarily listed companies, whereas many listed companies are required to disclose information about their CSR, sustainability, or ESG (environment, social, and governance). We, therefore, restrict our sample to Chinese listed companies in order to calculate the CSR score. According to the definition, CSR is related to people connected with the firm (employees, shareholders, consumers, suppliers, etc.), community, and environment. Items with a sufficient number of valid values in financial statements and statement notes that describe remuneration paid to employees, taxes paid to the government, and dividends to shareholders as the factors in CSR are all taken into consideration. The environmental factor is believed to be captured by green bond certification. The three factors are integrated into a single CSR score by, first, extracting factors using principal component analysis and, second, adding them up as they are standardized values. The two components contribute to the majority of variance (78%) in those items (Table 1).

Table 1. Principal component analysis and variance explained.

	Initial eigenvalues			Extraction sums of squared loadings		
Component	**Total**	**% of Var**	**Cumulative %**	**Total**	**% of Var**	**Cumulative %**
Com1	1.322	44.077	44.077	1.322	44.077	44.077
Com2	1.02	33.994	78.071	1.02	33.994	78.071
Com3	0.658	21.929	100			

Table 2. Variable definitions.

Variable	Definition
Spread	Bond yield spread (in percentage)
Label	Green bond certification. It equals 1 if the green bond is certified, and 0 otherwise.
CSR	CSR score of the bond issuer
IR	Issuer rating equals 1 if it is rated as AAA, and 0 otherwise
BR	Bond rating equals 1 if it is rated as AAA, and 0 otherwise
TypeFI	Equals 1 if financial bonds, 0 otherwise
TypeEN	Equals 1 if enterprise bonds, 0 otherwise
Maturity	Natural logarithm of the maturity of green bonds (in years)
Index	China Green Bond Index on the date of issuance
ROE	Return on equity
EI	EBITDA/Interest
FAT	Turnover of fixed assets

IR: The dummy variable for bond issuer rating. *IR* equals 1 if the green bond issuer is rated AAA, and 0 otherwise. More than half the companies focused on here have an AAA rating.

BR: The variable for bond rating. Like *IR*, most of the bond ratings here are AAA. Therefore, *BR* takes a value of 1 if the bond is rated AAA, and 0 otherwise.

Type: The variable for the type of bond. China has three types of bonds on the market: financial bonds issued by financial institutions, enterprise bonds issued by government agencies or state-owned enterprises (SOE), and corporate bonds issued by ordinary firms. We use two dummy variables to proxy for different types of issuers. The first is *TypeFI*, which takes a value of 1 for financial bonds, and 0 otherwise. And the second is *TypeEN*, which takes a value of 1 for enterprise bonds, and 0 otherwise.

Maturity: We take the natural logarithm of the maturity of green bonds (in years) in the regression.

Index: The China Green Bond Index on each issuing date, as an indicator of the market environment. The index, which consists of over 800 green bonds, has been published daily by the China Securities Depository and Clearing Corporation since 2016.

Meanwhile, we control for three financial ratios that describe a firm's profitability, liability, and operations: return on equity, EBITDA/interest (*EI*), and turnover of fixed assets. All the variables are summarized in Table 2.

3. Sample Description

In this study, we focus on the Chinese green bond market because China has played a leading role in the global green bond market since the end of 2014. As of 2018Q2, the total value of green bonds issued in China is about US$57.1 billion, which is about 13.3% of the worldwide total. Compared to the spontaneous development of green bonds in other countries from the bottom up, the Chinese green bond market is promoted mainly by the PBOC (the central bank), the National Development

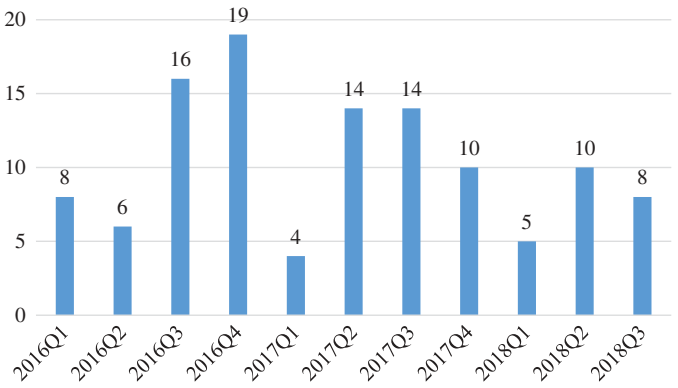

Figure 3. Frequency of green bond issuance by quarter.

and Reform Commission, and the CSRC. These governing bodies have implemented several regulations to promote green bonds and green projects to address climate change.

3.1. Sample

Although many companies have issued green bonds, we focus only on listed companies to ensure data accessibility, quality, and credibility. The certification process has only started to be implemented in recent years. Therefore, the observation window is from January 2016 to September 2018. Omitting other observations with unsound data, we end up with a sample of 114 green bonds from 58 issuers. All data regarding firms, the market, and the Treasury comes from the Wind database, which is a professional provider of financial data.

3.2. Descriptive Statistics

Figure 3 shows the frequency of green bond issuance by quarter in the sample, and Table 3 shows the descriptive statistics of quantitative variables. The average bond yield spread is 1.5%, with a range from 0.37% to 5.90%, which is relatively large. The average CSR score is standardized but right skewed.

The frequency of discrete variables is displayed in Figure 4. Only 41.22% of the bonds have been certified. Although the distribution of issuer ratings and bond ratings differs, all bonds are rated above AA-, and the majority of the sample is AAA, which reflects the creditworthiness of Chinese bonds and issuers. To date, no green bonds have defaulted.

Table 3. Descriptive statistics of continuous variables (N = 114).

Variable	Mean	Median	SD	Min	Max
SPREAD	1.50	1.22	0.09	0.37	5.90
CSR	−1.58E-06	0.00443	0.07	−1.26	3.33
Maturity	4.66	5.00	0.14	3.00	10.00
Index	106.11	104.03	0.39	99.67	111.68
ROE	10.77	10.84	0.53	−5.96	22.83
EI	6.31	6.31	1.67	−158.56	49.31
FAT	5.05	2.81	0.75	0.13	57.84

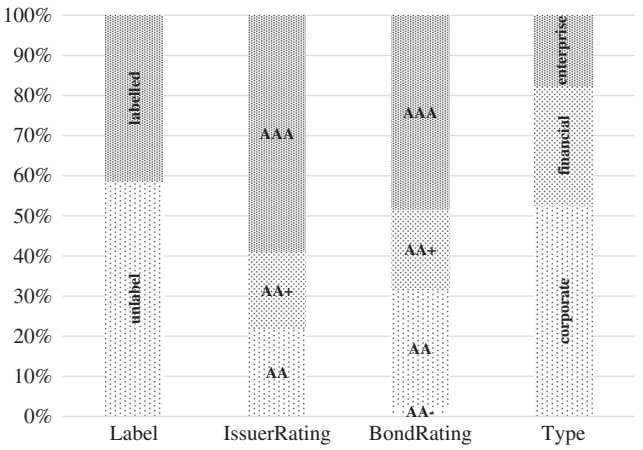

Figure 4. Frequency of discrete variables.

Table 4. Correlation matrix.

	CSR	Maturity	Index	ROE	EI	FAT
CSR	1					
Maturity	–0.163	1				
Index	0.026	0.221	1			
ROE	0.099	–0.279	–0.031	1		
EI	–0.015	0.075	0.148	0.174	1	
FAT	0.078	–0.151	0.138	0.329	–0.199	1

Table 4 provides the correlation matrix between quantitative independent variables in our study. None of the variables are highly correlated. All the correlation coefficients among selected variables in the correlation matrix are below 0.4. Multicollinearity is not a concern in our regressions.

4. Results

The ordinary least squares regression results of credit ratings, the CSR score, and certification on green bond yield spreads are shown in Table 5. All independent variables except the type of bonds and bond ratings are significant. The type of bonds does not make any difference, which means that issuer background is not important in the interest cost of bonds. Consistent with our expectation, the results show that certified green bonds with higher credit ratings or higher CSR scores have lower yield spreads and interest costs.

With respect to the credit rating, the empirical results illustrate the significant negative impact of higher issuer ratings on green bond yield spreads. The coefficient of *IR* is −0.494, with a *p*-value of less than 0.05, while that of *BR* is −0.14, with a *p*-value of 0.514. The reason for the difference in significance is that *IR* and *BR*, reasonably, are highly correlated (Kendall's tau correlation is 0.81). This shows that issuer ratings have greater power over bond ratings, a particular phenomenon in China, where investors are most concerned about the creditworthiness of the issuer. Their signs are both negative. The reasons for the negative impact on interest costs are consistent with the literature. First, conventional bonds with an AAA credit rating have relatively a lower risk of default, so investors usually charge a lower risk premium (Hull, Predescu, and White 2005), which is also true for green bonds. Second, investors rely on rating agencies to mitigate information asymmetry, and

Table 5. Model results.

$N = 114$	$R^2 = 0.64$	$F = 18.95$	$sig. = 0.000$
IV	**Coefficient**	***t***	***p*-value**
Label	−0.281*	−1.84	0.068
CSR	−0.184**	−2.36	0.020
IR	−0.494**	−2.25	0.027
BR	−0.140	−0.66	0.514
ln(Maturity)	−0.495**	−2.06	0.042
TypeEN	0.140	0.76	0.446
TypeFI	−0.370	−1.39	0.169
Index	−0.089***	−5.74	0.000
ROE	−0.042***	3.71	0.000
EI	0.007**	2.10	0.039
FAT	0.059***	7.76	0.000

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

credit ratings integrate unmeasurable information, particularly when the market is still insufficient in terms of severe information asymmetry. The green bond market is far from mature, and investors have no sound evaluation tools. But credit ratings act as the main indicator of potential risks. Openness and transparency are very important to investors. However, because of investors' lack of expertise in judging green projects, credit ratings become their primary information source in making bond selection decisions. Overall, although neither rating is significant due to correlation, we still have enough confidence that H1 will hold as expected, given its negative impact on interest costs, which indicates that bonds with lower credit ratings are expected to yield higher spreads.

We measure the CSR of a firm by introducing a score that integrates its responsibility to employees, shareholders, and society and finds that firms with higher CSR scores are capable of issuing green bonds at a lower cost. This supports H2. Waddock and Graves (1997) prove that corporate social performance is positively related to prior financial performance as well as future financial performance, supporting the theory that good management and corporate social performance are positively related. However, in many cases, CSR activities used in this article, such as taxes, expenses, and dividends, are costly, which may reduce the surplus profit of a firm. Nonetheless, based on our area of concern, at least in the bond market, investors regard it as a good signal, especially for green bonds. Therefore, firms that have higher CSR scores tend to be in a better financial condition with higher development potential, thus resulting in lower yield spreads.

The coefficient of *Label* is negative (−0.281), which supports H3. We find that the benefits of certification outweigh the cost of a stringent certification process. The CBI (2015) provides guidelines on how to issue a green bond in China, outlining four requirements that are necessary for green bonds.

1. Issuers need to identify qualifying green projects and assets, based on the Climate Bonds Standard;
2. An independent review can be arranged as a protection of business reputation;
3. Issuers need to ensure that tracking and reporting procedures are conducted routinely to guarantee that the proceeds from green bonds are used only for the specified green project, and report on the use of proceeds annually;
4. Issuers need to follow the same procedures in issuing the green bond as for a conventional bond.

As mentioned earlier, the certification of green bonds introduces extra costs in terms of both time and money paid to verifiers. Certification has both advantages and disadvantages, and issuers may

Table 6. Robustness test.

$N = 58$	$R^2 = 0.73$	$F = 10.47$	$sig. = 0.000$
IV	**Coefficient**	***t***	***p*-value**
Label	−0.120	−0.57	0.568
CSR	−0.300***	−3.81	0.000
IR	−0.73**	−2.07	0.044
BR	0.116	0.35	0.727
ln(Maturity)	−0.963**	−2.02	0.049
TypeEN	−0.112	−0.45	0.653
TypeFI	−0.934**	−2.35	0.023
Index	−0.090***	−4.04	0.000
ROE	−0.035**	−2.07	0.044
EI	0.005**	2.02	0.049
FAT	0.059***	7.76	0.000

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

face a trade-off when issuing green bonds, as third-party certification is not compulsory. However, our empirical results imply that certification is a wise choice. It works as a signal and can eliminate barriers for investors who are not familiar with the emerging green bond market. In general, better transparency and information disclosure regarding a green bond's use of proceeds actually create larger investment profit margins.

Control variables are further analyzed. The market index is negatively related to the yield spread by a margin of −0.089, which is similar to the impact of systemic factors on interest costs. Maysami, Lee, and Hamzah (2005) explain that when the market is strong, stakeholders also have strong confidence in their investments. It is widely recognized that systemic factors affect individual behavior. The sign of the coefficient of maturity is not as expected. In general, bonds with a longer maturity have a larger yield spread, but the result shows the opposite. It can also be explained as a signal effect. Firms that issue green bonds with a longer maturity convey the confidence necessary for bond financing, reflecting better corporate credit, and a better business environment. Analyzing the sample structure of bond maturity and corresponding bond credit ratings, we find that bonds with a longer maturity that are AAA rated make up a significant share of total bonds with that rating level. Other financial ratios work as we expect.

To verify the robustness of our results, we integrated multiple bonds issued by the same firm. Ge and Kim (2014) regard a firm's multiple annual issues as a portfolio and use the weighted averages of variables in their analysis. In a similar fashion, considering that the observation window of our sample is rather short, we combine all green bonds issued by the same firm into one portfolio, ignoring their issue dates. This methodology decreases cross-correlation problems, at the cost of losing various bond feature details and a significant reduction of our sample. After processing the sample, we repeat the regression analysis: the result is shown in Table 6, and our inferences remain unchanged, except that the certification variable is not significant. The underlying reason is that some firms have issued both certified and uncertified green bonds, so the effect of certification is neutralized.

5. Conclusion

This study explores the links between CSR, green certification, bond credit rating, and green bond yield spread in the Chinese market. Based on our empirical analysis, we find, consistent with previous research on the effect of credit rating on bond interest cost (He and Jin 2010; Steiner and Heinke 2001), that AAA firms take advantage of interest costs and firms with good CSR performance can reduce their costs (Oikonomou, Brooks, and Pavelin 2014). This association works as a signal effect (Waddock and Graves 1997):

corporations with higher CSR indicate their better financial condition, long-term development prospects, and overall potential. This study is the first to investigate the certification of green bonds. Green bonds, after being qualified through a third-party verification process, generally have low yield spreads, because a certificate is akin to a proof of transparent information disclosure in the use of proceeds, potential risks, and corporate governance.

Both the bond market and the emerging green bond market in China are developing rapidly. However, no clear universal guidelines have emerged for issuing green bonds globally. As clearly indicated, the certification of green bonds is related to the cost of debt for each corporation, which matters for both bond issuers and investors. Regulators should setup standards for certification, rather than leaving them to market discipline. The certification of "greenness" acts like another form of credit rating, though it receives much less attention than credit ratings. Additionally, certification helps investors identify green bonds and understand their fund flows, supports green programs using these bonds, and improves information symmetry. We also recommend that the government further encourage and promote the requirement for certification of green bonds.

Finally, given the data constraints, we limit our empirical study to listed companies. But the green bond market is growing so rapidly that it will soon be possible to analyze a larger sample. In addition, many other concerns may emerge for both the issuers and investors. For instance, issuers may want to maximize their benefits (e.g., low-interest cost in this article) from financing in the bond market when they have the option of issuing either green or non-green bonds. One direction of future research would be to extend our current work by comparing the results in both types of bonds issued by the same company.

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Notes

1 Available on the website of Climate Bonds Initiative: https://www.climatebonds.net/cbi/pub/data/bonds.
2 Available on the website of CBI: https://www.climatebonds.net/certification.

ORCID

Zhiyong Li http://orcid.org/0000-0001-9307-8453
Ying Tang http://orcid.org/0000-0001-8616-8522

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