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Can Labeled Green Bonds Reduce Financing Cost in China?

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Abstract: From the perspective of financing cost, this article investigates the benefits of green bonds to the issuer. Based on 227 green bonds and 405 conventional bonds selected from China's bond market, we find that (1) green bonds can decrease financing cost by at least 15 bps in the primary market, which is more significant than the effect in the secondary market; (2) third-party certification can strengthen the 'greenium' of green bonds in both the primary and secondary markets; and (3) there is no 'greenium' effect for financial green bonds in either primary or secondary markets in China, even for green bonds with third-party certification.

Keywords: labeled green bond; greenium; credit spread; financing cost

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1. Introduction

Over the past decade, China has paid increasing attention to issues of natural environment damage and resource shortage. To solve these problems, China has transformed the mode of economic development from high pollution and high energy consumption to green, efficient and sustainable development. Green investment and green financing play a vital role in this process of transformation [1,2]. Green bonds combine the traditional bond financing method with green projects, and have attracted increasing interest from both academia and industry all over the world. Since 2016, China's green bond market has developed rapidly and has become an important part of the Chinese green financial system. Four years after it was established, it has become one of the three largest green bond markets in the world. In 2020, the amount of green bonds issued globally reached 290.1 billion dollars, having increased by over six times in the past five years.

The most important difference between green bonds and conventional bonds is the 'green label'. Based on the market data of Chinese green bonds, we observe that more than half of green bonds have lower interest rates compared to non-green (conventional) bonds in the primary market. This article defines 'greenium' as the interest rate spread in the primary market or yield spread in secondary market between green bonds and conventional bonds. We aim to study this green premium effect in the primary and secondary markets, and investigate whether third-party certification could intensify this 'greenium' effect. In line with previous studies, we also verify the existence of 'greenium' for financial green bonds in China.

Our sample includes the data of green bonds issued from 2016 to 2020 in the primary market and trading data from June 2020 to December 2020 in the secondary market in China. To address the concern of endogeneity, each green bond is matched with at least one conventional bond with the same maturity, industry and other bond characteristics. Moreover, our results also highlight the importance of third-party certification on the 'greenium' effect. The study offers some important insights into the role of bond financing in green economics, which may help solve the issue of low-level investment in renewable areas [3–5].

Our conclusion are as follows. First, green labels will bring cost advantages to bond issuers. The spread is reduced by 15 bps due to the 'greenium' effect in the primary market,

but it is not statistically significant in the secondary market. Secondly, the third-party certification may reduce the financing cost of green bonds. The interest rate advantage of the certified bonds is 27 bps in the primary market. In the secondary market, the third-party certified bonds still maintain an interest rate advantage for more than 30 bps, though it is less significant in the secondary market. Finally, we conduct interactive regression to investigate the premium effect, especially for green bonds issued by financial institutions. There is no 'greenium' effect for financial green bonds in either the primary market or the secondary market, and nor for green bonds with and without third-party certification.

The rest of this article proceeds as follows. Section 2 provides a literature review, Section 3 displays hypothesis development, Section 4 explains the research model design, Section 5 presents the empirical results, and Section 6 makes conclusions and gives policy implications.

2. Literature Review

This research contributes to two main branches of literature. First, the article adds to the empirical research on influencing factors of green bond pricing. Hachenberg and Schiereck (2018) [6] revealed that ESG (environment, social responsibility, corporate governance) rating had a greater impact on green bond credit spreads than on conventional bonds. Febi et al. (2018) [7] found that the LOT liquidity played a role in the yield spread of green bonds, but its impact decreased over time. After examining co-movement between green bonds and financial markets, Reboredo (2018) [8] put forward that the green bond market had a high correlation with the corporate bond and national bond markets.t Some studies have shown that the green premium may vary with time and corporate social responsibility (CSR). Pham and Luu (2018) [9] found that investor attention could influence green bond return and volatility, but this relationship was time varying. Kanamura (2020) [10] argued that green bond performance was superior to that of conventional bonds; however, the superiority decayed over time. Wang et al. (2020) [11] compared the price premium of corporate green bonds with conventional bonds in terms of CSR and ownership.

Second, our finding contributes to the corporate finance literature. As we mentioned before, scholars are concerned about the impact of the green label on the financing cost of corporate bonds, but there is no consensus yet. Bachelet et al. (2019) [12] found that the green bond spread is higher than the conventional one, and they believed the type of issuer could explain this, while other research found that the 'greenium' is not obvious in the bond market [13,14]. Tang and Zhang (2018) [15] documented that green bond issuance made a positive influence on the issuer's stock price and liquidity, and could bring benefits to stakeholders of the issuer. Zerbib (2019) [16], Suk et al. (2020) [17] and Wang et al. (2020) [11] showed that green bonds' premiums varied with countries, investors, issuers and regulatory systems. Based on yields of 110 green bonds from various countries, Zerbib (2019) [16] demonstrated that the green label could reduce 2bps of yield. Suk et al. (2020) [17] showed that green bonds certified by an external reviewer enjoyed a premium of about 6 bps. Larcker and Watts (2020) [18] compared 627 pairs of green bonds with conventional bonds using Nearest Neighbor Matching Method, and they denied the 'greenium' effect in bond market.

Overall, whether the 'greenium' effect exist in the bond market still very argued. There are limited previous studies that distinguish the 'greenium' effect in the primary and secondary markets, and also the important role of third-party certification on the 'greenium' effect. In this paper, we study the 'greenium' effect in the primary and secondary bond markets in China, and analyze the function of third-party certification on the green premium effect.

3. Hypothesis Development

The purpose of issuing green bonds is to endogenize the positive externalities of green capital investment in bond security. The 'greenium' effect is the 'price premium' in green bonds compared with conventional one. However, whether the 'greenium' exists in

China's bond market has engendered controversies. Supporters believe that green bonds can offer attractive risk–return profiles compared to conventional (non-green) ones [6]. They see issuance of green bonds as a signal of corporate social responsibility (CSR) for the issuer [19]. It can be seen that green bonds have unique features compared to conventional bonds, which may stimulate capital flows to the green bond market and reduce green project financing costs. As a result, we propose our first hypothesis of the 'greenium' effect in China bond market as follows.

Hypothesis 1 (H1). *Compared to conventional bonds, green bonds have lower financial cost in the primary and secondary markets.*

How does the 'greenium' effect comes abouts? Macaskill et al. (2020) organized the drivers of 'greenium' into three factors: social, economic and environmental [14]. The premium effect of green bonds coincides with an increasing demand for socially responsible investment (SRI) products amongst investors, and green bonds are less risky or volatile than convention ones [20]. In fact, external review (third-party certification) is a mandatory tool to ensure that the bond issued satisfies the condition of being green (climate bonds certificate) [21]. The findings of Hyun et al. (2019) [17] back up the important effect of third-party certification on the 'greenium'. In China, third-party certification of green bonds mainly includes two aspects. One is the screening and certification of green projects and the other is the control system and the compliance assessment and certification. It is noteworthy that green bonds with third-party certification in China are featured as environment-friendly with efficient internal control and transparent information disclosure, which may reduce investors' latent risks [22–24]. Therefore, we can make our second hypothesis about third-party certification on the 'greenium' effect as follows.

Hypothesis 2 (H2). *Green bonds with third-party certification can intensify the effect of the 'greenium'.*

Fatica et al. [25] pointed out that there is no green premium effect in the case of green bonds issued by financial institutions (financial green bond). They attributed this phenomenon to investors' lack of ability to identify a clear link between green bonds issued by a financial institution and a specific green investment project. We also investigate the 'greenium' effect for financial green bonds in China and make our third hypothesis, as below.

Hypothesis 3 (H3). *There is no 'greenium' effect for green bonds issued by financial institutions.*

4. Method

4.1. Model Specification

To test the above three hypotheses, we employ multiple-regression based on the matched bonds data. The equations are as follows:

$$Spread_i = \alpha_0 + \beta_1 Green_i + \sum \beta_i X_i + \sum \theta_i Y_i + \sum \omega_i Z_i + \delta_t + \gamma_i + \varepsilon_i \quad (1)$$

$$Spread_i = \alpha_0 + \beta_1 Green_i + \beta_2 Green\_Cert_i + \sum \beta_i X_i + \sum \theta_i Y_i + \sum \omega_i Z_i + \delta_t + \gamma_i + \varepsilon_i \quad (2)$$

$$\begin{aligned} Spread_{it} = \alpha_0 + \beta_1 Green_{it} + \beta_2 Green_{Cert_{it}} + \beta_3 Green_{Cert_{it}} \times Financial_{it} + \beta_4 Financial_{it} \\ + \sum \beta_i X_{it} + \sum \theta_i Y_{it} + \sum \omega_i Z_{it} + \delta_t + \gamma_i + \varepsilon_i \end{aligned} \quad (3)$$

where $Spread_i$ is the issuance spread in the primary market and yield spread in the secondary market for bond i. Yield spread is equal to the yield to maturity (YTM) of a corporate bond minus the risk-free interest rate. We collect twelve different terms of treasure yield in CEIC database as risk-free interest rates and use the treasure yield with terms closest to

each corporate bond's remaining maturity to calculate the yield spread in the secondary market.

$Green_i$ is a dummy variable equal to 1 if bond i is a kind of green bond and 0 otherwise. If Hypothesis 1 holds, the coefficient of $Green_i$ should be less than 0. $Green\_Cert_i$ is a dummy variable equal to 1 if the bond is certificated by a third-party and 0 otherwise. Third-party certification is a feature that only certain green bonds have. If third-party certification plays an important part in the 'greenium' effect, the coefficient of $Green\_Cert_i$ should be significantly negative. $Financial_i$ is a dummy variable equal to 1 if the bond is issued by a financial institution. We use the cross term of $Green\_Cert_i \times Financial_i$ to investigate the impact of third-party certification on green bonds issued by financial institutions and compare this result with Fatica et al. [25].

We use control variables in the regression to absorb the influence of other variables on $Spread_i$. (1) X_i represents control variables of bond characteristics, including logarithmic issuance amount, credit rating, maturity and dummy variables of callable and puttable options embedded in bonds. (2) Y_i is the issuer characteristics [26,27], including state-owned enterprise dummy variables, return on equity and corporate leverage. (3) Z_i refers to macro-factors [28] including inflation rate, currency growth rate and bond type dummy variables. In the empirical analysis of the secondary market, another variable, *maturity_remain*, is added to the control variables in the regression, denoting the remaining maturity of the bond. δ_t and γ_i are the fixed-time effect and fixed-industry effect in the model.

All variables are shown in Table 1. The data of explained variables and control variables about bond and corporate characteristics are collected from the Wind database, and macro-variable data comes from the CEIC. We collect data of third-party certification from the green bond database of *Xinhua Finance* and then distinguish whether a green bond have third-party certification or not.

Table 1. Variable definitions.

Variables	Definition		Direction
Issuance spread	Issuance interest rate minus risk-free interest rate		/
Yield spread	Yield to maturity minus risk-free interest rate		/
Green	Equal to 1 if the bond defined as a green bond and 0 otherwise		–
Certification	Equal to 1 if the bond has a third-party certification and 0 otherwise		–
Bond characteristics	Size	The natural logarithm of the issuance amount	–
	Rating	Aaa = 5, aa+ = 4, aa = 3, aa- = 2, a+ = 1	–
	Maturity	The natural logarithm of the maturity of debt	+
	Callable	Equal to 1 if the bond is a callable bond and 0 otherwise	+
	Puttable	Equal to 1 if the bond is a puttable bond and 0 otherwise	–
	Maturity_remain	Remaining maturity of the bond	–
Macro-economic factors	CPI	CPI in China as a proxy for inflation rate	+
	M2	Year on year growth rate of China's M2 money supply	–
Corporate characteristics	SOE	Equal to 1 if the firm is state-owned firm and 0 otherwise	–
	ROE	Return on equity.	–
	Leverage	The ratio of total debts to total assets.	–

4.2. Data and Matching Method

We collect primary-market data of corporate bonds issued by financial institutions, companies and state-owned enterprises (SOE) in China since 2016, and also monthly data of

corporate bond trading from June 2020 to December 2020 in the secondary market. In order to avoid the endogeneity problem, we match green bonds with similar conventional bonds to minimize the effects of other factors on spreads based on the method used by Zerbib (2019) [16]. In our research, we match each green bond with comparable conventional bonds with the same maturity, the same rating, nearest maturity dates (interval less than 1 year), similar capitalization (difference less than five times) and issuers from the same industry as defined by the China Securities Regulatory Commission. In other words, the conventional bonds ought not to have significant differences from the corresponding green bonds except for the green label.

5. Empirical Analysis

5.1. 'Greenium' in the Primary Market

5.1.1. Data Description

After the matching process, a total of 632 green bonds and corresponding conventional bonds issued during 2016–2020 were obtained, including 227 green bonds and 405 conventional one. The selected sample accounts for more than 70% of green bonds in the China green bond market. There are 174 green bonds issued by companies, 249 green bonds issued by SOEs, and 209 green bonds issued by financial institutions in the selected sample. Table 2 reports descriptive statistics of all variables and the *T*-test results for the issuance spread in the primary market classified by green, SOE and third-party certification.

Table 2. Data description and *T*-test results.

Panel A. Summary statistics						
	N	Unit	Mean	S.D.	Min	Max
Credit spread	632	%	1.730	1.036	0.296	5.175
Green	632	Dummy	0.359	0.480	0	1
Maturity	632	Year	5.057	2.006	2	10
Ln(size)	632	100 million	2.461	0.878	−1.204	5.991
Rating	632	Dummy	4.445	0.816	1	5
Callable	632	Dummy	0.035	0.183	0	1
Puttable	632	Dummy	0.196	0.397	0	1
M2	632	%	9.455	1.269	8.000	13.400
CPI	632	Index	102.304	1.103	99.500	105.400
SOE	632	Dummy	0.394	0.413	0	1
Certification	632	Dummy	0.182	0.149	0.000	1.000
ROE	632	Proportion	0.048	0.001	0.046	0.203
Leverage	632	Proportion	0.679	0.173	0.216	0.946
Panel B. *T*-test for dependent variable by groups						
Variable	N	Mean	N	Mean	Difference	
Credit spread	Conventional bonds		Green bonds		0.165 *	
	405	1.789	227	1.625		
	Other green bonds		SOE green bonds		−1.109 ***	
	136	1.180	91	2.289		
	Green bonds without certification		Green bonds with certification		0.864 ***	
	112	2.062	115	1.198		

Notes: *** and * represent significance at 1% and 10%, respectively.

In panel A, the issuance spread has an average value of 1.728 for all bonds. The mean values for green, SOE and third-party certification are 0.359, 0.394 and 0.182, which means our sample is 35.9% green bonds, 39.4% SOE bonds and 18.2% green bonds with third-party certification.

In panel B of Table 2, the univariate *t*-test is used to observe the mean difference between green and conventional bonds in each bond pair. As we can see, the mean difference of issuance spread between conventional bonds and green bonds is 0.165 and is significant at a 10% level. The credit spread of conventional bonds is significantly larger than that of green ones, although it is more moderate than the result in Wang et al. (2020) [11]. Considering that the green and conventional bonds in each pair are matched with the same characteristics, this result means that the green label may reduce bond financing cost. The mean differences between SOEs and other issuers is −1.109 and 0.864 for the mean difference of green bonds with third-party certification and bonds without it, all significant at a 1% level. In other words, SOE bonds have higher issuance spread, while bonds with a third-party certification have lower issuance spread.

The univariate *t*-test of other variables shows that there is no significant difference in indicators such as maturity period, issuance scale and call and put options other than the green label, which means the bond pairs selected can be used to investigate the effect of the 'issuance greenium'.

5.1.2. Empirical Results

Table 3 reports the regression results of the relationship between green bonds and financing cost (Model (1)). We add the fixed year effect and fixed industry effect to the model. In the first column of Table 3, the coefficient of the *Green* is significantly negative at a 1% level, which means that the green label negatively influences issuance spread when issued. This agrees with our first hypothesis that green bonds can reduce corporate financing cost. This finding can be supported by the idea that environmental, social, and governance (ESG) has a greater impact on green bond issuance spreads, which suggests that bonds issued to fund projects with environmental benefits reduce the cost of capital for the issuer [29]. We add bond characteristics, macro-economic factors and corporate characteristics into the model sequentially from the second column to the fourth column of Table 3. The coefficients of *Green* stay negative and significant. From Table 3, we conclude that green bonds can reduce at least 15 bps issuance spread compared with conventional bonds at the time issued, which is nearly 9% of the average credit spread in China's corporate bond market.

Next, we focus on the effect of third-party certification on the 'issuance greenium'. We develop the second hypothesis that third-party certification may result in the price premium of green bonds. The empirical results are shown in Table 4. Columns (1) to (4) show the regression results of Model (2), which introduce the effect of the third-party certification on green bonds in the model. The coefficients of *Green_Cert* are all negative and significant at 1% level, with a strong effect of 'issuance greenium'. The loading on *Green* is absorbed by the third-party certification effect. It can be seen that third-party certification can reduce the cost of green bonds additionally by 27 bps in column (4), which strongly supports our second hypothesis that part of the 'greenium' effect comes from the third-party certification effect. This result coincides with the 34 bps price premium of green bonds calculated by Wang et al. (2020) [11].

Table 3. Effect of green bonds on issuance spread in the primary market.

	(1)	(2)	(3)	(4)
Green	−0.166 ***	−0.180 ***	−0.183 ***	−0.158 ***
	(−2.66)	(−3.07)	(−3.12)	(−2.69)
Ln(size)		−0.337 ***	−0.334 ***	−0.328 ***
		(−10.25)	(−10.26)	(−10.39)
Rating		−0.061	0.030	0.024
		(−0.80)	(0.34)	(0.29)
Maturity		0.083 ***	0.084 ***	0.042
		(2.80)	(2.84)	(1.40)
Callable		0.303	0.335 *	0.508 ***
		(1.40)	(1.68)	(2.60)
Puttable		−0.292 ***	−0.234 **	−0.244 **
		(−2.69)	(−2.14)	(−2.30)
CPI			0.114 ***	0.108 ***
			(3.43)	(3.36)
M2			0.173 **	0.189 **
			(2.22)	(2.47)
SOE				−0.324 ***
				(−4.52)
ROE				−1.944 ***
				(−2.82)
Leverage				−0.699 **
				(−2.29)
Fixed-year effect	YES	YES	YES	YES
Fixed-industry effect	YES	YES	YES	YES
Constant	1.556 ***	1.959 ***	−11.900 ***	−10.724 ***
	(10.30)	(6.17)	(−3.34)	(−3.09)
N	632	632	632	632
Adjusted R^2	0.415	0.501	0.514	0.538

Notes: ***, ** and * represent significance at 1%, 5% and 10%, respectively. Robust standard errors are reported in the parentheses.

In previous research of Fatica et al. [25], there is no price premium for green bonds issued by financial institutions. We investigated whether there is a common phenomenon for the financial green bonds in China's bond market. Among the 632 bonds screened in the sample, 207 green bonds are issued by financial institutions. The effect of third-party certification on the 'issuance greenium' of financial green bonds is shown in Table 5. It can be seen that though the coefficients of cross terms, including $Green_i \times Financial_i$ and $Green\_Cert_i \times Financial_i$, are all negative, this is not significant in our regression model. In other words, even third-party certification cannot effectively improve the 'issuance greenium' of green bonds issued by financial institutions in China.

5.1.3. Robust Test

For the robust test, we match the green bonds and conventional bonds with a more strictly method. The green bonds and conventional bonds in each pair must be issued by the same issuer, and each pair of bonds have the same rating and maturity. We compare the difference of average issuance spreads between green bonds and conventional ones in the matched pairs. Based on the selected 44 bonds issued by 16 issuers, 12 issuers' green bonds show lower issuance spread than their conventional bonds, with an average issuance spread reduction of 13.1 bps, which is closer to the results in Table 3.

Table 4. Effect of third-party certification on 'greenium' in primary market.

	(1)	(2)	(3)	(4)
Green	−0.035	−0.021	−0.031	−0.020
	(−0.36)	(−0.23)	(−0.35)	(−0.23)
Green_Cert	−0.260 **	−0.314 ***	−0.300 ***	−0.277 ***
	(−2.55)	(−3.28)	(−3.16)	(−2.83)
Ln(size)		−0.350 ***	−0.347 ***	−0.340 ***
		(−10.64)	(−10.71)	(−10.80)
Rating		−0.058	0.037	0.029
		(−0.77)	(0.42)	(0.34)
Maturity		0.072 **	0.073 **	0.033
		(2.43)	(2.49)	(1.09)
Callable		0.273	0.310	0.477 **
		(1.29)	(1.57)	(2.47)
Puttable		−0.286 ***	−0.230 **	−0.243 **
		(−2.65)	(−2.12)	(−2.30)
CPI			0.108 ***	0.104 ***
			(3.32)	(3.27)
M2			0.180 **	0.194 **
			(2.29)	(2.51)
SOE				−0.326 ***
				(−4.52)
ROE				−1.999 ***
				(−2.99)
Leverage				−0.607 *
				(−1.94)
Fixed-year effect	YES	YES	YES	YES
Fixed-industry effect	YES	YES	YES	YES
Constant	1.551 ***	2.068 ***	−11.300 ***	−10.260 ***
	(10.46)	(6.49)	(−3.22)	(−2.99)
N	632	632	632	632
Adjusted R^2	0.420	0.508	0.520	0.543

Notes: ***, ** and * represent significance at 1%, 5% and 10%, respectively. Robust standard errors are reported in the parentheses.

5.2. 'Greenium' in Secondary Market

5.2.1. Data Description

The 3768 observations in our sample were collected monthly from June 2020 to December 2020 in China's secondary bond market. Table 6 reports descriptive statistics of all variables and the *T*-test results for the yield spread in the secondary market classified by green, SOE and third-party certification. In panel A, the yield spread has an average value of 1.501 for all observations. The mean values for green, SOE and third-party certification are 0.360, 0.218 and 0.181, which means that our sample is 36.0% green bonds, 21.8% SOE bonds and 18.1% green bonds with third-party certification.

Table 5. The effect of 'issuance greenium' of financial green bonds.

	(1)	(2)	(3)
Green	−0.158 ***	−0.013	−0.023
	(−2.69)	(−0.11)	(−0.20)
Green_Cert			−0.229
			(−0.98)
Financial		−0.467	−0.468
		(−1.43)	(−1.46)
Green × Financial		−0.297 *	
		(−1.77)	
Green_cert × Financial			−0.142
			(−0.56)
Ln(size)	−0.170 ***	−0.107	−0.119 *
	(−2.60)	(−1.58)	(−1.74)
Rating	−0.474 ***	−0.506 ***	−0.497 ***
	(−7.89)	(−8.38)	(−8.21)
Maturity	−0.400 ***	−0.409 ***	−0.419 ***
	(−11.53)	(−11.81)	(−11.94)
Callable	0.531 *	0.340	0.311
	(1.93)	(1.22)	(1.12)
Puttable	0.018	−0.021	−0.001
	(0.14)	(−0.16)	(−0.01)
CPI	0.108 ***	0.109 ***	0.108 ***
	(3.36)	(3.41)	(3.39)
M2	0.189 **	0.190 **	0.187 **
	(2.47)	(2.47)	(2.43)
SOE	−0.393 ***	−0.525 ***	−0.505 ***
	(−2.69)	(−3.51)	(−3.38)
ROE	−2.464 **	−2.198 **	−2.394 **
	(−2.30)	(−2.05)	(−2.22)
Leverage	0.959 **	1.465 ***	1.448 ***
	(2.09)	(3.05)	(3.03)
Fixed-year effect	YES	YES	YES
Fixed-industry effect	YES	YES	YES
Constant	−10.724 ***	−10.862 ***	−10.739 ***
	(−3.09)	(−3.15)	(−3.13)
N	632	632	632
Adjusted R^2	0.538	0.540	0.541

Notes: ***, ** and * represent significance at 1%, 5% and 10%, respectively. Robust standard errors are reported in the parentheses.

Table 6. Summary statistics.

Panel A. Summary statistics						
	N	Unit	Mean	S.D.	Min	Max
Yield spread	3768	%	1.501	3.281	−4.810	8.444
Green	3768	Dummy	0.360	0.480	0	1
Maturity_remain	3768	Year	3.139	2.243	0.167	9.87
Ln(size)	3768	100 million	2.953	3.515	−1.204	5.991
Rating	3768	Dummy	4.331	1.027	1	5
Callable	3768	Dummy	0.035	0.184	0	1
Puttable	3768	Dummy	0.197	0.398	0	1
SOE	3768	Dummy	0.218	0.413	0	1
Certification	3768	Dummy	0.181	0.176	0.000	1.000
ROE	3768	Proportion	0.058	0.055	0.018	0.246
Leverage	3768	Proportion	0.680	0.173	0.216	0.946
Panel B. *T*-test for dependent variable by groups						
Variable	N	Mean	N	Mean	Difference	
Credit spread	Conventional bonds		Green bonds		0.327 ***	
	2412	1.619	1356	1.292		
	Other green bonds		SOE green bonds		−0.637 ***	
	810	1.035	546	1.672		
	Green bonds without certification		Green bonds with certification		0.646 ***	
	672	1.613	684	0.976		

Notes: *** represent significance at 1%.

In panel B of Table 6, we test the mean difference of yield spread between green and conventional bonds with the same method in the secondary market. Yield spread between green bonds and conventional bonds is more significant than the result in the primary market. The mean difference of yield spread between conventional bonds and green bonds is 0.327, also larger than the result in the primary market. The mean difference between green bonds issued by SOEs and other issuers is −0.637, shrinking in the secondary market. The mean difference between green bonds with third-party certification and those without is 0.646, significant at a 1% level. In the secondary market, we may expect the same effect of the 'greenium' in terms of third-party certification as that in primary market.

5.2.2. Empirical Results

To study the 'greenium' in the secondary market and the influence of third-party certification on it, we regress the full-sample data and the sub-sample bond pairs of green bonds with third-party certification. Results are shown in Table 7.

Table 7. Effect of green bonds on yield spread in the secondary market.

	(1)	(2)	(3)	(4)
	Full Sample	**Certificated Green Bonds Pairs**	**Uncertificated Green Bonds Pairs**	**Full Sample with Intersection**
Green	−0.332 ***	−0.560 ***	−0.066	−0.155
	(−3.24)	(−2.92)	(−0.90)	(−1.14)
Green_Cert				−0.353 *
				(−1.95)
Ln(Size)	−0.170 ***	−0.352 **	−0.174 ***	−0.189 ***
	(−2.60)	(−2.30)	(−4.12)	(−2.85)
Maturity_Remain	−0.400 ***	−0.566 ***	−0.416 ***	−0.408 ***
	(−11.53)	(−9.63)	(−12.18)	(−11.69)
Rating	−0.474 ***	−0.571 ***	−0.309 ***	−0.465 ***
	(−7.89)	(−5.42)	(−6.61)	(−7.73)
Callable	0.531 *	1.200 ***	0.668 ***	0.021
	(1.93)	(4.87)	(3.69)	(0.16)
Puttable	0.018	−6.598 **	−0.995 ***	−2.531 **
	(0.14)	(−2.45)	(−9.38)	(−2.36)
Roe	−2.464 **	2.092 ***	−2.987 ***	1.079 **
	(−2.30)	(2.66)	(−4.64)	(2.34)
Leverage	0.959 **	−0.499	−1.200 ***	−0.400 ***
	(2.09)	(−1.33)	(−3.17)	(−2.74)
SOE	−0.393 ***	−0.499	−0.263 ***	−0.560 ***
	(−2.69)	(−1.33)	(−3.00)	(−2.92)
Month fixed effect	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES
Constant	5.224 ***	3.908 ***	6.891 ***	5.201 ***
	(12.78)	(6.72)	(12.54)	(12.74)
N	3768	1938	1830	3768
Adjusted R-Squared	0.099	0.163	0.110	0.100

Notes: ***, ** and * represent significance at 1%, 5% and 10%, respectively. Robust standard errors clustered by issuers are reported in the parentheses.

Table 7 shows that in the full sample regression, the coefficient of green is −0.332, which is still significant in the secondary market. This result is consistent with findings by Hyun et al. (2019) [17]. This result has an important economic meaning; the green label reduces bond financing cost both in primary and secondary markets. We also analyze the effect of third-party certification on the price premium effect of green bonds in this section. In columns (2) and (3), we study the 'greenium' effect of certificated green bonds and green bonds without third-party certification, respectively, using the sub-sample. The coefficient of *Green* certified by a third party is −0.560 and significant at the level of 1% in column (2). By comparison, the *Green* coefficient of the bonds without certification shown in column (3) is −0.066 and insignificant, much weaker than that with third-party certification. We then run the model with cross term $Green_i \times Certification_i$ using the full sample in column (4). In this regression, the $Green_i \times Certification_i$ coefficient is −0.353 and significant under the 10% confidence interval. This means that the third-party certification could enhance the 'greenium' effect in the secondary market by about 35 bps. This crucial function of certification in the green bond market may be related to the improvement of fund management and information disclosure by third-party monitoring, which improve the confidence of investors in China.

As in the previous section about primary market, we consider the impact of third-party certification on 'greenium' of financial green bonds in the secondary market as well. The

premium effect of financial green bonds is shown in columns (2) and (3) in Table 8. It can be seen that there is no significant 'greenium' effect for financial green bonds in the secondary market, even for the green bonds with third-party certification. This finding is in line with Fatica et al. [25] that there is no premium effect for green bonds issued by financial institutions.

Table 8. The effect of 'greenium' of financial green bond in the secondary market.

	(1)	(2)	(3)
Green	−0.425 ***	−0.518 ***	−0.216
	(−3.74)	(−3.76)	(−1.57)
Green × Financial		0.277	
		(1.16)	
Green_cert × Financial			0.198
			(0.71)
Financial		−0.236	−1.538 ***
		(−1.63)	(−4.27)
Green_cert			−0.395 *
			(−1.75)
Ln(Size)	−0.426 ***	−0.429 ***	−0.119 *
	(−6.52)	(−6.55)	(−1.74)
Maturity_Remain	−0.334 ***	−0.339 ***	−0.419 ***
	(−8.74)	(−8.83)	(−11.94)
Rating	0.104 *	0.092	0.116 **
	(1.90)	(1.63)	−0.497***
Callable	0.785 **	0.283 *	0.311
	(2.48)	(1.87)	(1.12)
Puttable	0.267 *	−2.767 **	−0.001
	(1.77)	(−2.42)	(−0.01)
Roe	−2.702 **	1.466 ***	−2.394 **
	(−2.37)	(2.83)	(−2.22)
Leverage	1.504 ***	−0.606 ***	1.448 ***
	(2.91)	(−3.76)	(3.03)
SOE	−0.611 ***	−0.429 ***	−0.505 ***
	(−3.79)	(−6.55)	(−3.38)
Industry-fixed effect	YES	YES	YES
Time-fixed effect	YES	YES	YES
Constant	3.491 ***	3.532 ***	3.696 ***
	(6.41)	(6.44)	(6.53)
N	3768	3768	3768
Adjusted R-Squared	0.095	0.096	0.098

Notes: ***, ** and * represent significance at 1%, 5% and 10%, respectively. Robust standard errors clustered by issuers are reported in the parentheses.

6. Conclusions

The purpose of this article is to examine how green bonds influence corporate financing cost in both primary and secondary markets. Based on green bonds and conventional

bonds issued from 2016 to 2020 in China's bond market, the results show that (1) compared with conventional bonds, green bonds can reduce corporate financing cost by at least 15 bps in the primary market. (2) Third-party certification has a significant effect on reducing the financing cost of green bonds both in the primary and secondary markets. It can reduce at least additional 27 bps issuance spread for green bonds in the primary market, especially. (3) In line with previous studies, no 'greenium' effect exists for green bonds issued by financial institutions; even the third-party certification cannot reduce financing cost significantly for financial green bonds.

The study is limited by the lack of green and conventional bond pairs. China's green bond market is still immature compared with other developed bond markets. We use a green and conventional bonds matching method based on Zerbib (2019) [16] instead of using green and conventional bonds issued by the same issuer in our regressions. Notwithstanding this limitation, this study helps us promote our insight into the financing cost advantage of green bonds. The result of this study indicates that green bonds can reduce issuers' funding costs, especially for insurance spread in the primary market. This price premium effect partly comes from the special features of green bonds and third-party certification can enhance this premium effect.

Taken together, this thesis provides a deeper insight into the development of the green bond market. Improving the coverage of third-party certification in the green bond market would be a functional way to stimulate the development of the green bond market. Certification from third parties helps improve the environment benefits and plays a role in risk prevention and investors' risk management. A further study could access the practical effect of third-party certification on the green bond premium and the performance of green bonds issued by financial institutions.

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