

Intermediary Mechanism Study on the Impact of ESG Assessment on Bond Issuance Interest Rates

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Abstract: ESG (Environmental, Social, and Governance) assessment is a widely recognized system for evaluating corporate sustainable development by international investors. The emphasis and improvement of ESG indices can have multiple effects on corporate operations and development. This paper focuses on the impact of ESG on corporate bond financing interest rates, considering the relevant relationships and intermediary mechanisms involved. The results indicate that, with controlled variables considered, corporate bonds with higher ESG scores tend to have lower issuance interest rates. Furthermore, besides the direct impact on bond rates, ESG scores also generate indirect effects through the intermediary variable of "financing constraints." The study establishes from a corporate financing perspective that the development of ESG assessment has positive implications for corporate operations and confirms the intermediary role of financing constraints in this causal chain. According to the results, targeted recommendations are proposed for corporate operations: to reduce financing costs, continually optimize ESG and financing constraints.

Keywords: ESG, Bond issuance interest rates, Intermediary mechanism

1. Introduction

The development of global enterprises faces various challenges related to sustainable development, such as the impact of climate change and natural resource depletion on the external environment or upstream/downstream resources, the implementation of corporate social responsibility leading to sustainable economic win-win situations and social harmonious development, and the enhancement of corporate resource integration and comprehensive management capabilities. These issues have drawn significant attention to sustainable development and have continuously prompted enterprises to clarify their roles and responsibilities in addressing these challenges. ESG (Environmental, Social, and Governance) is currently a mainstream comprehensive evaluation system for sustainable development internationally, and its principles align well with China's current concept of "high-quality development." As a critical force for social development, enterprises should strive for high-quality development, not solely focusing on improving financial indicators but also emphasizing comprehensive performance, including market position, innovation, and sustainable development [1]. The concept of ESG has been developing for over three decades in foreign countries, and a considerable number of investors have already integrated ESG criteria into their company assessments. Rating agencies such as FTSE have constructed differentiated ESG evaluation systems

based on company disclosures, government public information, and proprietary databases. Due to investors' ESG information demands and the inclusion trend of ESG indices by institutions, many foreign companies have shifted from mandatory to voluntary ESG disclosures. In China, the ESG evaluation system is still in the early stages of rapid development. As of 2022, a total of 101 institutions have signed the RPI (Principles for Responsible Investment), of which 22 are public funds. The current institutions launching ESG evaluations in China include China Asset Management, CICM Fund Management, Shanghai Green Finance Committee, China Securities and Fund Association, RKS, China Everbright, CFEGI, Wind Information, and others [2]. Presently, domestic ESG research mainly focuses on ESG rating systems [2], corporate information disclosure and ESG performance [3], the concept of carbon neutrality and ESG [4], ESG ratings, and listed company performance [5].

Bonds are one of the essential financing tools for enterprises. The issuance interest rate of bonds plays a crucial role in the bond market, directly affecting the bond market, issuers, and investors. Issuers need to strike a balance between issuance interest rates and attractiveness to investors to manage their issuance costs. Similarly, investors use the issuance interest rate, combined with their risk tolerance and expected return, to make informed investment decisions. There is considerable research on the factors influencing bond issuance interest rates: Chen Kejing et al. [6] found through empirical research that anti-takeover clauses in company charters do not affect a company's ability to successfully issue bonds but increase issuance costs and shorten the issuance period. Geng Deke [7] tested 7,900 bond data and concluded that company ratings have a more significant impact on the issuance rate than bond ratings; moreover, as credit ratings increase, the marginal influence of debt ratings becomes relatively stable, while the marginal influence of the issuer's rating decreases. Huang Chao [8] studied the factors affecting green bond issuance rates and pointed out that third-party certification has an endorsement function, helping to reduce the issuance rate of green bonds. Shen Yiqing [9] used Monte Carlo simulations to test the relationship between information transparency and bond issuance capital costs, concluding that companies with complete information disclosure will obtain lower issuance rates. Based on the above research, the selected control variables mainly include benchmark interest rates, issuance periods, guarantee methods, issuance amounts, ownership structures, issuance regions, whether they are subordinate bonds or green bonds, and some financial indicators and rating results of listed companies, providing a reference and support for establishing the basic model of this paper.

Many scholars have also discussed the relationship between ESG and bonds. Chen Wan [10], through empirical testing, believes that higher ESG levels correspond to lower bond default probabilities. Generally, companies with lower default probabilities can obtain funds at lower costs. Research on the factors influencing bond issuance interest rates is abundant and mature. Regarding the intermediary mechanism of ESG on bond issuance costs, Li Jinglin et al. [11] demonstrated that ESG indices can influence bond financing costs through three aspects: corporate information transparency, operational risks, and financing constraints, ultimately resulting in a negative impact on bond rates. Zhu Kang et al. [12] found that the disclosure of ESG ratings mainly negatively affects bond financing costs through the channels of agency costs and analyst attention. As an unavoidable hot topic of this era, how the issuer's ESG score affects the bond issuance interest rate, how ESG influences the issuance rate through intermediary variables, and the contribution of these intermediary variables will be studied in this research. The content of this study can complement the theories of bond cost and ESG impact and provide practical reference significance for corporate sustainable development policies and debt financing businesses.

The structure of this paper is as follows: the first part is the introduction, the second part is data selection and model design, the third part is experimental results and conclusion analysis, and the fourth part is the conclusion and policy recommendations.

2. Theory and Method

2.1. Mediating Variables

Mediating variables play a significant role in statistics and have important conceptual and functional implications. Incorporating mediating variables into different research can display the essential relationship between variables in a more scientific and quantitative manner. A mediating variable refers to the intermediary through which an independent variable affects a dependent variable; it is the essential and inherent reason for the impact of the independent variable on the dependent variable. In other words, considering the influence of the independent variable X on the dependent variable Y, if X affects the variable M, which then influences Y, M is considered the mediating variable. In simpler terms, the independent variable exerts its effect on the dependent variable through the mediating effect. Usually, when a variable factor is added to the model, changes occur between the independent and dependent variables, and the relationship between them can be clearly explained. In such cases, the variable factor may be a mediating variable, affecting the independent variable.

Edward Chase Tolman (1932) proposed the "Stimulus-Organism-Response" (S-O-R) model based on Watson's "Stimulus-Response" (S-R) theory, which illustrates that the effect of stimuli on responses occurs through internal organismic processes. In this context, the "organism" serves as a mediating variable. Liu Hongyun et al. [13] suggested that when there is a sufficient amount of data, using linear regression for analysis results in smaller errors. Therefore, when the dependent variable is an ordinal variable with at least five categories, conventional linear regression can be considered for testing the mediating effect. Wen Zhonglin, Hou Jietai, and Zhang Lei [14] proposed that a variable may be both a mediating variable and a moderating variable, and the position and effect of a third variable are not fixed. Whether a third variable in the model is a mediating variable or a moderating variable depends on the purpose of the model. The study also organized the concept of mediating variables and conducted a systematic analysis of them. Lu Xiefeng and Han Limin [15] indicated that assuming there is a high correlation between the independent variable and the dependent variable, when a mediating variable is added between them, if the correlation or regression coefficient between the independent variable and the dependent variable significantly decreases (reducing to 0 indicates complete mediation), it can be considered that there is a significant mediating effect, indicating that the mediating variable can effectively explain the relationship between the independent variable and the dependent variable.

2.2. Method

The main model used in this study is the cross-sectional regression model for the intermediary mechanism. In the model, "j" represents different bonds, "IRT" denotes the bond issuance interest rate after removing the impact of the economic cycle (i.e., the difference between the bond issuance interest rate and the benchmark interest rate at the time of issuance). "ESG_MA" represents the issuer's wind ESG comprehensive score and is the core variable. "M" serves as the mediating variable.

The model is expressed as follow equation:

$$IRT_j = \alpha + \beta_1 ESG_MA_j + \beta_2 M_j + \beta_3 Controls_j \quad (1)$$

Table 1: Variable Description.

Variable Type	Variable Name	Remarks
Dependent Variable	Bond Issuance Interest Rate	Difference between issuance interest rate and benchmark interest rate at the time of issuance
Core Variable	ESG Score	2020.6 Wind ESG data
Mediating Variable	Financing Constraints	SA Index
	Bond Issuance Period	
	Bond Issuance Size	
Control Variables	Issuer's Asset Size	2020 Annual Report data
	Issuer's ROE	2020 Annual Report data
	Issuer's Province	Assigned values 1-31 based on GDP ranking
	Listed Company Status	Listed: 1, Non-listed: 0
	Latest Bond Rating	Assigned into 19 categories

The selection of control variables in this study is mainly based on previous research on factors influencing bond costs. Chen Kejing et al. [6] selected control variables such as bond ratings, bond guarantees, underwriter ratings, company size, debt-paying ability, growth capability, and interest coverage. Huang Chao et al. [8] selected control variables such as size, ROE, leverage ratio, company nature, and term. Geng Deke et al. [7] selected control variables such as time trend: ranging from 2007 to 2016 to reflect factors like technical progress, institutional reform, and regulatory improvements over time; rating year: 10 dummy variables ranging from 2007 to 2016; and rating agency. The ten rating agencies include Dagong International, Oriental Goldcredit, Shanghai Far East, New Century, China Chengxin International, China Chengxin Securities, United Credit, United Credit Rating, Pengyuan International, and China Lianhe Credit, represented by ten dummy variables. In this study, the Controls variable includes seven variables: bond issuance period, bond issuance size, issuer's province, bond rating, issuer's asset size, issuer's ROE, and listed company status.

3. Results

3.1. Experimental Data

The bond sample used in this study consists of 13,320 corporate bonds from the Shanghai Stock Exchange. After matching the wind ESG comprehensive scores of issuers, the sample size is reduced to 12,744 bonds. The basic attributes and data processing methods are presented in Table 2:

Table 2: Data Information.

Variable Name	Number	Mean	Standard Deviation	Minimum	Maximum
Bond Issuance Interest Rate	11,946	0.99	1.51	-4.15	7.90
ESG Comprehensive Score	11,949	5.73	1.56	0.00	7.61
Financing Constraints	11,599	7.58	1.72	2.11	16.10
Bond Issuance Period	11,949	4.76	2.14	0.41	30.00
Bond Issuance Size	11,949	9.33	11.43	0.20	500.00
Logarithm of Asset Size	11,707	24.84	1.22	20.19	30.32
Issuer's ROE	11,676	1.94	8.51	-261.20	52.34
Province	11,946	8.14	6.46	1.00	31.00
Listed Company	11,949	0.07	0.25	0.00	1.00
Bond Rating	11,949	2.33	1.90	1.00	19.00

All the above data will be standardized before regression analysis, but the standardized data will not be presented in this paper due to space limitations.

3.2. Testing for Multicollinearity using Variance Inflation Factor (VIF)

Multicollinearity among variables can often affect the fitting ability and results of regression models. Using the Variance Inflation Factor (VIF) to test the multicollinearity in the regression model is a commonly used method. Typically, if the VIF value is close to 10, it indicates the presence of multicollinearity among variables.

Table 3: Multicollinearity Test

Variable Name	VIF	1/VIF
Asset Size	1.66	0.60
Bond Rating	1.64	0.61
Bond Issuance Size	1.17	0.86
ROE (Return on Equity)	1.14	0.88
Listed Company	1.05	0.95
Province	1.05	0.95
Bond Issuance Period	1.02	0.98
Mean VIF	1.25	

The maximum VIF value is 1.66, and the mean value is 1.25. The results indicate that the data and variables have passed the test for multicollinearity.

3.3. Regression Results

(1) Basic Regression Results

The direct impact of the core variable: The wind ESG comprehensive score of issuers has a significant negative correlation with bond issuance interest rates, as shown in Table 4.

Table 4: Basic Regression Results

Bond Issuance Interest Rate	Coefficient	Standard Deviation	t-value	P > t [95% Confidence Interval]
ESG	-0.07	0.01	-8.55	0.00
Bond Issuance Period	-0.02	0.01	-2.06	0.04
Bond Issuance Size	-0.14	0.01	-16.70	0.00
Asset Size	-0.07	0.01	-7.00	0.00
Province	0.22	0.01	27.57	0.00
Listed Company	-0.29	0.01	-36.56	0.00
Bond Rating	0.50	0.02	31.46	0.00
ROE (Return on Equity)	-0.01	0.01	-0.68	0.50
Constant	0.03	0.01	3.51	0.00

The results indicate a negative correlation between the ESG score and bond issuance interest rates. For every unit increase in ESG rating, the average bond issuance interest rate decreases by 0.04 percentage points. In other words, higher ESG scores correspond to lower issuance interest rates. A higher ESG score implies better performance in environmental, social, and corporate governance aspects for the bond issuer. This can increase market trust in the issuer, thereby reducing investment risk. Therefore, investors generally perceive bonds with higher ESG scores as more reliable and sustainable, making them willing to purchase these bonds at lower interest rates. There is a negative correlation between bond issuance period and interest rates, with an average decrease of 0.07 percentage points for every unit increase in the issuance period. This means that bonds with shorter terms typically enjoy higher issuance interest rates. Companies with excellent qualifications that can issue long-term bonds face lower reinvestment risk for the longer term. In a constantly changing interest rate environment, issuing longer-term bonds allows issuers to lock in lower fixed interest rates, reducing reinvestment risk caused by interest rate fluctuations. Additionally, lower reinvestment risk makes investors more inclined to purchase longer-term bonds, increasing the demand for the issuer's bonds and subsequently reducing bond issuance costs. There is a negative correlation between bond issuance size and interest rates, with an average decrease of 0.02 percentage points for every unit increase in issuance size, meaning that larger issuance size corresponds to lower interest rates. Larger bond issuance size imposes higher requirements on the issuer, leading to lower credit risk. Therefore, investors are more willing to purchase such bonds, resulting in reduced issuance interest rates. There is a negative correlation between issuer's asset size and interest rates. For every unit increase in asset size, the average interest rate decreases by 0.14 percentage points, meaning that larger asset size corresponds to lower interest rates. A larger asset size indicates more sources of cash flow and collateral, higher market visibility, higher credit ratings, and stronger debt-paying capacity. Consequently, investors are willing to purchase these bonds at lower interest rates. There is no significant correlation between ROE and interest rates. There is a significant positive correlation between province ranking by GDP and interest rates. A higher GDP ranking for a province corresponds to lower issuance costs. A higher GDP ranking usually indicates a better financial condition and credit level. The credit rating of the province is an important consideration when issuing bonds, and a higher credit rating can lower the bond issuance cost. There is a negative correlation between whether the issuer is a listed company and interest rates. Issuance costs for bonds of listed companies are lower. Listed companies are subject to regulatory supervision by securities regulatory authorities and must comply with disclosure and financial information disclosure requirements. This transparency and supervision make it easier for investors to assess the company's credit risk. Furthermore, bonds of listed companies typically have higher liquidity in the secondary market, making it relatively easy for investors to find buyers even if they need to sell the bonds on the market. This liquidity further reduces bond issuance costs.

There is a significant positive correlation between bond ratings and interest rates. A higher bond rating corresponds to lower issuance costs. Bond rating is an important indicator for evaluating the repayment ability and credit risk of debt. Rating agencies assess various factors such as the issuer's financial condition, debt structure, repayment ability, and industry competitiveness to assign credit ratings. Bonds with higher credit ratings have lower credit risks, and investors are willing to accept lower interest rates to purchase these bonds.

(2) Mediation Mechanism

1. Relevant Theories of Mediation Mechanism

The intermediary variable chosen in this study is financing constraints. When companies lack financial support, they need to seek financing. Financing can be done through two ways: internal financing and external financing. Internal financing refers to the company's own strong cash flows, such as cash on hand, accounts receivable, and retained earnings. External financing refers to raising funds from the market, such as bank loans and bond issuance.

The concept of financing constraints was first proposed by Modigliani and Miller, who believed that under the conditions of a strong efficient market, internal and external capital of companies are interchangeable in a perfect market. Therefore, in a perfect market, the investment behavior of companies is not influenced by internal conditions but only relates to their financing needs. However, in the real world, perfect markets do not exist, and there are problems of asymmetric information and agency in the market. The imperfection of financial markets can lead to differences between internal and external financing costs for companies, and when the financing behavior of companies is constrained by the market, they face financing constraints. As financing constraints are influenced by various factors, such as external market environment and internal governance, it is difficult to quantify them directly. Therefore, domestic and foreign scholars use some variables as indicators to measure the degree of corporate financing constraints.

Commonly used measures of financing constraints include KZ index, SA index, and WW index. However, the KZ index requires the use of cash dividends for calculation, making it inapplicable for non-listed companies. Additionally, the representation of the Tobin's q, which represents the investment opportunity of the company, in the KZ index has a very high possibility of error, reducing the accuracy of measurement. The WW index considers not only internal assets of the company but also issues related to cash flows and leverage, leading to bidirectional interactive effects. To avoid endogeneity interference, Hadlock and Pierce [16] divided the types of corporate financing constraints based on financial reports and then only used two variables, company size, and company age, which do not change significantly with events, to construct the SA index. The financing constraint measure used in this study is the SA index.

The SA index model is as shown in Equation (1):

$$SA_t = -0.737 \times size_t + 0.043 \times size_t^2 - 0.04 \times age_t \quad (1)$$

where SIZE represents the company's size, and AGE represents the length of time the company has been established. The SA index is generally negative, and the larger the absolute value of the SA index, the higher the degree of corporate financing constraints.

2. Impact of Including the Mediating Variable on the Core Variable

After including the mediating variable: The mediating variable significantly influences the dependent variable, and the P-values of the core variable and control variables are all reduced. All independent variables have significant effects on the dependent variable, as shown in the table below:

Table 5: Impact of Including the Mediating Variable on the Core Variable

Bond Issuance Interest Rate	Coefficient	Std.err.	t	P>t	95% conf.	interval
Financing Constraints	0.22	0.04	5.27	0.00	0.14	0.30
ESG	-0.07	0.01	-8.67	0.00	-0.08	-0.05
Bond Issuance Period	-0.02	0.01	-2.08	0.04	-0.03	0.00
Bond Issuance Size	-0.14	0.01	-16.81	0.00	-0.16	-0.12
Asset Size	-0.29	0.04	-6.77	0.00	-0.37	-0.20
Province	0.22	0.01	27.39	0.00	0.20	0.23
Listed Company	-0.28	0.01	-36.12	0.00	-0.30	-0.27
Bond Rating	0.49	0.02	30.86	0.00	0.46	0.52
ROE	-0.01	0.01	-0.90	0.37	-0.02	0.01
Constant	0.03	0.01	3.53	0.00	0.01	0.04

3. Sobel-Goodman Mediation Test for the Mediating Variable

First, the Sobel-Goodman Mediation Tests table shows that the P-values for all three indirect effect tests are less than 0.05, providing support for considering income as the mediating variable in the impact of education on health. Additionally, after considering the influence of financing constraints, the impact of ESG decreases by approximately 0.013. The results are shown in the table below:

Table 6: Sobel-Goodman Mediation Tests

	Est	Std err	z	P>z
Sobel	0.001	0	2.021	0.043
Aroian	0.001	0	1.991	0.046
Goodman	0.001	0	2.053	0.04

Table 7: Mediating Variable Effect

Proportion of total effect that is mediated:	-0.013
Ratio of indirect to direct effect:	-0.012
Ratio of total to direct effect:	0.988

4. Conclusions and Policy Recommendations

This study adopts the most of outstanding corporate bonds listed on the Shanghai Stock Exchange as the research sample and employs the mediation variable multiple regression method to investigate the impact of ESG scores on bond issuance interest rates and the mediating variable. The research findings are as follows: (1) ESG scores have a significant negative impact on bond issuance interest rates, meaning that higher ESG scores are associated with lower bond issuance interest rates; (2) The financing constraint SA index serves as the mediating variable. Besides directly affecting bond issuance interest rates negatively, higher ESG scores also indirectly influence bond issuance interest rates by reducing financing constraints.

The contributions of this study are as follows: (1) It empirically demonstrates the importance of ESG scores in the development of companies, especially their financing; (2) It uses mediation tests to measure the direct and indirect effects of ESG scores on bond issuance interest rates; (3) It provides corresponding policy recommendations based on the experimental results:

Besides evaluating a company's financial performance, ESG scores also consider factors related to the environment, society, and governance. For modern investors, these scores provide a more

comprehensive understanding of the company's current capabilities and better predict its future development, taking into account governance methods, compliance with green environmental goals, and the social credibility of investment targets. Companies can use ESG scores to identify potential risks and enhance their ability to cope with future risks, while improving corporate governance and promoting sustainable development.

Financing constraints refer to the difficulties that companies face when issuing bonds. It is known that ESG scores have a significant impact on bond issuance interest rates, and there is a certain correlation between financing constraints and the ESG score system. When incorporating the financing constraint variable, the impact of ESG scores on bond issuance interest rates decreases by approximately 0.013. Therefore, financing constraints serve as the intermediary variable through which ESG scores significantly influence the cost of bond issuance. When financing constraints are higher, the bond issuance interest rates are lower. As financing constraints consider the company's age and financial condition, they better reflect the impact of ESG scores on the cost of bond issuance.

The actual cost of corporate financing includes both financing expenses and the use of funds. Financing expenses refer to various fees incurred by companies in raising funds, while the use of funds involves the repayment of principal and interest after the bond issuance. Based on the empirical findings of this study, higher ESG scores lead to lower bond issuance interest rates. Thus, when a company has a higher ESG score and demonstrates strong sustainability, investors are willing to purchase its bonds at lower interest rates. Therefore, companies with higher ESG scores can reduce their financing costs in terms of the use of funds. Similarly, higher ESG scores also indicate lower financing constraints, making it easier for companies to issue bonds, reducing time and resource consumption in the process, and effectively lowering financing costs from financing expenses. Therefore, companies should pay attention to the correlation between ESG scores and financing costs, strengthen effective management of ESG scores, and reduce financing costs.

* this paper is sponsored by 2023 Lijiang Culture and Tourism College School-Level Research Project

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