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How does ESG performance reduce financial risk — Evidence from China listed companies

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Abstract. The concept of sustainable green development has attracted considerable interest, with a diverse range of stakeholders from the environmental, social, and corporate governance (ESG) sectors demonstrating a keen interest in it. This paper presents an experimental investigation into the effect of ESG performance on financial analysis, utilising annual data from a-share listed businesses between 2010 and 2022. The findings indicate that financial risk can be reduced by strong ESG performance. The influence mechanism study found that by easing financing limitations, enhancing corporate ethical culture, and raising the bar for corporate innovation, companies with strong ESG performance primarily lower their financial risk. The results of the heterogeneity study indicated that smaller, non-state-owned, and eastern area businesses had better results when it came to lowering financial risk. Through the empirical test of ESG performance on financial risk, this paper offers insights for enterprises and investors to prioritize ESG performance and for government departments to enhance ESG incentive policies.

Keywords: ESG performance; Financial Risk; Financing Constraints; Ethical Culture; Innovation Level.

1. Introduction

Recently, with the advancement of global integration, issues such as environmental pollution,and so on have become increasingly prominent, making sustainable green development a consensus across society."Environmental, Social, and Governance (ESG) is a business management and investment philosophy proposed by the United Nations in 2004 that emphasizes green and coordinated development of the economy, environment, and society, and harnesses the power of capital to solve social and Environmental, Social, and Governance (ESG).

However, despite that, for most Chinese listed companies, investing in the ESG field may consume resources allocated to the core business of the enterprise that affects the profitability of the enterprise and increases financial risks. If they cannot demonstrate that fulfilling ESG responsibilities has a clearly positive impact on the company, it will be difficult to promote a situation where companies actively invest in the ESG field. So, in this context, it becomes crucial to determine the relationship between ESG performance and corporate financial risk. Existing research indicates that good ESG performance can help alleviate financing constraints,reduce financial risk, and ultimately enhance corporate value. However, some companies may hide negative information for the sake of their public image, making it difficult for them to take timely and effective remedial measures, thereby increasing the probability of financial risk[1].So,what is the relationship between ESG performance and financial risk?

Compared with the existing literature, this paper may have the following contributions : First, based on the real data of listed companies,this paper refines existing research on ESG performance; Secondly, this study analyzes its mechanism from the perspective of financing constraints, corporate

innovation and corporate ethical culture, and empirically tests its impact effect and path mechanism, which improves the logical chain of ESG performance affecting corporate financial risk; Third, it examines the impact of ESG performance on corporate financial risk under different conditions.

2. Theoretical analysis and research hypothesis

2.1. Good ESG performance is conducive to reducing corporate financial risk

Most scholars have a positive attitude towards the relationship between ESG performance and corporate financial risk. Yan Youbing pointed out that ESG can reduce the financial risk from the aspects of alleviating agency costs and improving social reputation[2]. Marketing competitiveness in the context of ESG is a comprehensive ability to integrate a firm's knowledge resources and tangible or intangible resources for value creation, thereby improving the ability to withstand risk and engage in risk avoidance.

According to the stakeholder theory, enterprises actively assume environmental responsibility, social responsibility is conducive to better meet the expectations of stakeholders.According to the resource-based theory, enterprises pay attention to environmental protection, actively fulfill their social responsibilities and improve corporate governance to obtain the key strategic resources can enhance their ability to resist risks[3] ; ESG performance enables enterprise managers to better restrain their own behavior, so that the enterprise itself pays more attention to the healthy development of employees, which is conducive to enhancing employees ' sense of identity with enterprise value,and improving team cohesion, so as to reduce corporate financial risks. Based on the above analysis, the hypothesis H1 is proposed.

H1: Good ESG performance is conducive to reducing corporate financial risks.

2.2. The mechanism path of ESG performance to reduce corporate financial risk

(1) The mitigation effect of ESG performance on financing constraints

Stakeholder theory holds that the survival of enterprises is inseparable from stakeholders such as government, shareholders and consumers. On the one hand, enterprises that consciously fulfill their environmental responsibilities and social responsibilities have lower moral hazards and are more likely to win the trust of stakeholders, thereby enhancing their intention of additional investment, alleviating financing constraints, providing cash guarantees and reducing financial risks. At the same time, studies have shown that high ESG means high elasticity, and investors who hold stocks of companies with high ESG ratings will be more patient ,and will not sell stocks in large quantities to avoid losses in volatile markets[4]. Therefore, those enterprises with higher ESG ratings will maintain more stable stock prices, and enable their additional financing to be easier relatively, thus resulting in lower bankruptcy risk as well as financial risk when the sudden events come.

On the contrary, according to the principal-agent theory, as an agent, the management has the management right and actual control right of the enterprise, and has more information than the stakeholders. The management may use the information difference to infringe the interests of the stakeholders for personal gain, resulting in information asymmetry between them. When an enterprise fulfills its ESG responsibility, it will increase its interaction with the external environment, pay attention to responding to the demands of stakeholders and maintaining the relationship. Stakeholders ' understanding of the enterprise will also deepen, and the information they grasp will also increase, thus enhancing their investment tendency to the enterprise and reducing financial risks. At the same time, enterprises with good ESG performance have a better internal governance system, creditors have higher trust in financial reports and face fewer risks, thus reducing the financial risks faced. Based on the above analysis, the hypothesis H2 is proposed.

H2: Good ESG performance can reduce financial risks by easing financing constraints.

(2) The enhancing effect of ESG performance on corporate ethical culture

From the perspective of managers, managers are important stakeholders within the enterprise. When misconduct occurs, it is bound to lead to corporate risks. The active commitment of ESG responsibility by enterprises is conducive to the formation of a good organizational culture within the enterprise, which can have a positive impact on the decisions of managers, so that they can solve the problems faced in a planned way, and avoid the financial risks brought by major moral problems to enterprises. At the same time, ESG performance focuses on the company 's supervision mechanism, and incorporates owners and managers into the same governance system, improve the stability of management, and then reduce financial risks.[5]

From the perspective of enterprises, good ESG performance helps enterprises accumulate moral capital, play a certain insurance effect, and help enterprises better cope with the adverse impact faced by enterprises. Good ESG performance is conducive to promoting the establishment of a solid trust relationship between enterprises and stakeholders, so that enterprises can better survive the emergence of problems such as customer loss and financing difficulties under the deterioration of the external environment, thus reducing the losses caused by negative events. When the enterprise has a good ESG performance, it helps to convey the positive image of the healthy development of the enterprise to the market, and it is easier to obtain the recognition of stakeholders When negative news occurs, this gives the enterprise opportunity to correct the deviation, avoid huge economic losses, and reduce financial risks. Based on the above analysis, the hypothesis H3 is proposed.

H3: Good ESG performance can reduce financial risks by optimizing corporate ethical culture.

(3) The driving effect of ESG performance on enterprise innovation

According to the theory of resource advantage, the ability of enterprises to master resources and use resources is the basic component of enterprise competitive advantage. The key reason lies in its two characteristics of specificity and heterogeneity. Specificity means that these resources are immobile within the enterprise and cannot be easily imitated or replaced by external competitors; while heterogeneity means that the resources can satisfy the unique preferences of consumers in specific market segments. So, enterprises to master the significant heterogeneity resources, will constantly innovation input and output, makes the enterprise can better consumer demand,to create more value, at the same time the value of competitive advantage increase usually into higher sales and profits, and ease the financial risk.

According to the theory of psychological contract, when the enterprise meets the non-material needs of employees, employees will more actively return to the enterprise. When an enterprise actively assumes ESG responsibilities, it can meet the psychological expectations of employees, improve their job satisfaction, and help unite internal employees, improve the efficiency of technology communication so as to promote enterprise innovation[6]. The innovation behavior of employees can promote the innovation output of the enterprise, help the enterprise to occupy and maintain the competitive advantage, improve the income and operating efficiency of the enterprise, so as to alleviate the financial risks Based on the above analysis, the hypothesis H4 is proposed:

H4: Good ESG performance can reduce the financial risk by improving the level of enterprise innovation.

Based on the above analysis, the mechanism path chart of ESG performance and corporate financial risk is as follows(Figure1):

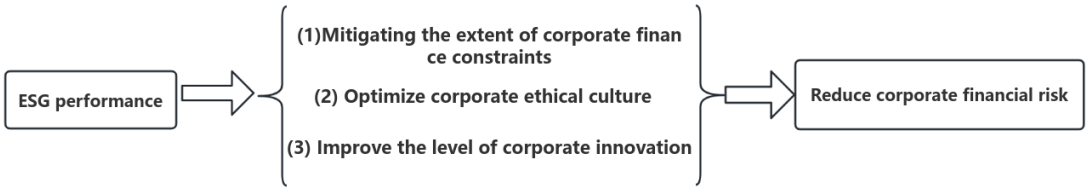

Figure 1. Mechanism path

3. Research Design

3.1. Sample selection and data description

In this paper, the initial samples are selected from the annual data of China's A-share listed companies from 2010 to 2022, and processed as follows: (1) the guidelines for industrial classification of listed companies (2012 amendment) released by the China Securities Regulatory Commission (CSRC) is used as the classification standard, and the samples of financial and real estate industries are excluded; (2) the samples of T category, such as ST or *ST, are excluded; (3) the samples with a large number of missing values of variables are excluded, and a total of 35,299 N are finally gained. To avoid extreme values affecting the empirical results, all continuous variables are subjected to the upper and lower 1% cut off treatments. These treatments ensure the reliability and representativeness of the sample, while avoiding the influence of extreme values and outliers on the results.

In this paper, company ESG ratings and specific scores are from CSI's ESG rating data, GDP data from China Statistical Yearbook, company patent data from China Research Data Service Platform (CNRDS), violation data from RISE database and other data from Cathay Pacific database.

3.2. Definition of variables

3.2.1. Explained Variables

Explained variables is enterprise financial risk (Z). In this paper, Altaman's (1968) Z-score model is adopted to estimate corporate financial risk.[7]. The structure of the model is as follows:

$$\mathrm{Z-score} = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5 \quad (1)$$

Where: $X_1$is the ratio of Working Capital to Total Assets, X_2 is the ratio of Retained Earnings to Total Assets, X_3 is the ratio of EBITDA to Total Assets, $X_4$is the ratio of Shareholders' Equity to Total Liabilities, and $X_5$is the ratio of Sales to Total Assets.Variables were selected for the reference.

The company's financial position can be assessed using the $\mathrm{Z-score}$: $\mathrm{Z-score}$>2.6 indicates that the enterprise is in a healthy financial position and faces a low risk of insolvency; 1.1<$\mathrm{Z-score}$<2.6 indicates that the enterprise may be in a state of potential insolvency and that the risk exists but is manageable; $\mathrm{Z-score}$<1.1 indicates that the enterprise faces a high risk of insolvency.

3.2.2. Explanatory variables

Explanatory variables are enterprise ESG Performance (ESG).The CSI ESG ratings are selected to measure corporate ESG performance. The CSI ESG ratings classify ESG into nine grades from AAA, AA, A, BBB, BB, B, CCC, CC, and C in descending order from high to low. In this paper, ESG performance is assigned a value of 1 to 9 from low to high.

3.2.3. Mechanism variables

(1) Financing constraints

In this paper, we refer to this existing literature , to measure the degree of firms' financing constraints with WW index. Livdan D et al constructed the WW index by GMM estimation of the Euler equation of investment, which is a linear combination of six factors: cash flow, dividend payment dummy variable, gearing ratio, company size, industry sales revenue growth rate and company sales revenue growth rate. The higher the WW index, the higher the constraints that firms face in the financing process[8].

$$\mathrm{WW_{i,t}} = -0.091 \times \mathrm{CF_{i,t}} - 0.062 \times \mathrm{DDiv_{i,t}} - 0.021 \times \mathrm{Lev_{i,t}} - 0.044 \times \mathrm{Size_{i,t}} + 0.102\mathrm{ISG_{i,t}} - 0.035\mathrm{SG_{i,t}} \quad (2)$$

Where: CF is the ratio of operating Cash Flow to Total Assets; DDiv is a dummy variable for dividend payment, which is 1 when the firm pays dividends and 0 otherwise; Lev is the gearing ratio;

Sizeis the natural logarithm of the firm's total assets; ISG is the sales growth rate of the industry in which the firm operates; SG is the rate of operating income growth for the firm.

(2) Corporate Ethical Culture

In this paper, we refer to Yan Youbing, Yi Qixu[2] to measure the corporate ethical culture by the corporate violation (Violate), measured by the number of times notified of penalties by the Securities and Exchange Commission (SEC) or relevant government departments in that year, and the lower the number of times notified of penalties, the higher the corporate ethical culture.

(3) Innovation level

In this paper, we refer to Fang Xianming and Na Jinling[9] who used the number of patent applications (Patent-applied) and the number of patents actually owned (Patent-owned) as a measure of the innovation level of the enterprise, and they all show a positive relationship

3.2.4. Control variables

Drawing on the existing literature, this paper introduces the control variable, at the enterprise level including enterprise scale (Size), asset-liability ratio (Lez), total assets net interest rate (ROA), cash flow ratio (Cash-flow), fixed assets (Fixed), operating income growth rate (Growth), total assets growth rate (Asset-Growth), the number of directors (Board), independent directors (India), two unity (Dual), equity concentration (Top1), the company established fixed number of year (Firm-Age), property rights (SOE); At the regional level, it includes the level of economic development (GDP-Growth).

3.2.5. Descriptive statistics

Descriptive statistics for the main variables are reported in Table 1 after shrinking the continuous variables at the 1% and 99% levels. The mean value of Z value is 4.967, and the standard deviation is 5.538, which reflects great differences in the financial risks between different listed companies. The mean value of ESG is 3.978, and the standard deviation is 1.222, indicating that the average ESG rating of the sample enterprises is between CCC and B, and most of these ratings are between CC and BB, and there is still much room for improvement in ESG performance.

Table 1. Descriptive statistics

Type	Variables	N	Mean	Standard deviation	Min	Max
Explained variables	Z value	35299	4.967	5.538	0.164	35.502
Explanatory variables	ESG	35299	3.978	1.222	1.000	8.000
Mechanism variables	WW index	35299	-1.009	25.080	-13.667	0.000
	Patent-applied	35299	81.483	382.988	0.000	16399.000
	Patent-owned	35299	60.976	278.442	0.000	10016.000
	Violated	35299	0.258	0.766	0.000	38.000
Control variables	Cash-flow	35299	0.245	0.410	-0.607	2.142
	Lez	35299	0.409	0.204	0.051	0.878
	ROA	35299	0.046	0.062	-0.194	0.228
	Fixed	35299	0.208	0.156	0.002	0.687
	Asset-Growth	35299	0.232	0.436	-0.259	2.709
	Growth	35299	0.168	0.362	-0.514	2.126
	Size	35299	22.172	1.293	19.941	26.219
	Firm-Age	35299	2.838	0.368	1.609	3.497
	Dual	35299	0.291	0.454	0.000	1.000
	Top1	35299	0.349	0.148	9.340	74.820
	Board	35299	8.497	1.625	5.000	14.000
	Indep	35299	0.376	0.053	0.333	0.571
	GDP-Growth	35299	9.935	0.684	7.432	10.737
	SOE	35299	0.354	0.478	0.000	1.000

3.3. Specification of Model

3.3.1. Model Selection

In economic research, it is usually assumed that the same regression equation slope of the individual observes its commonality, and different intercept terms are different to reflect the heterogeneity between individuals. This model is called the ' individual effect model ', that is:

$$Y_{it} = \beta_1 X_{it} + \beta_2 Z_1 + \mu_1 + \varepsilon_{it} (i = 1,2,\ldots. n; t = 1,2.\ldots T) \quad (3)$$

Among them, Z_1 is an unobservable variable that does not change with time. If μ_1 is related to an explanatory variable, it means that μ_1 exists in a fixed form, which is called the ' fixed effect model ' (FE). If $\mu_1$is not related to all explanatory variables, it means that the manifestation of $\mu_1$is random, which is called the ' random effect model ' (RE). In order to study which model is more applicable, using the Hausman test to take the further research. The original hypothesis of the Hausmann test is that ' H0 : $\mu_1$andε_{it}must be independent and identically distributed ', that is, the random effect model is effective. The result of Hausman test is shown in Table 2 :

Table 2. The result of Hausman test

	Fixed Effect	RE
VARIABLES	Z value	Z value
ESG	0.338***	0.364***
	(9.150)	(10.645)
Constant	32.420***	23.683***
	(18.351)	(20.496)
N	36,088	36,088
R^2	0.114	

chi2(12) = 424.12: Prob > chi2 = 0.0000

Since the P value in the Hausman test is 0.0000, the null hypothesis H0 is strongly rejected, that is, the fixed effect model should be used instead of the random effect model.

3.3.2. Baseline model

In order to test the hypotheses and explore the impact of ESG performance on financial risk, referring to the research results of Zhai Shengbao et al[10], this paper constructs the following benchmark model:

$$\text{Financial Risk}_{i,t} = \alpha_0 + \alpha_1 \text{ESG}_{i,t} + \sum \alpha_j \text{Controls}_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (4)$$

In equation (3), subscripts i and t denote industry and year, respectively; ESG is the ESG performance variable, Controls is the control variable;ε is the random disturbance term; μ_i and λ_t denote controlling for firm-fixed and time-fixed effects, respectively;$\alpha_0$are the intercept parameters;$\alpha_1$are the coefficients on the ESG performance variables; $\alpha_j$are the coefficients on each of the control variables. In this paper, robust standard error is used to control the influence of heteroscedasticity.

3.3.3. Mechanism testing model

To test and H1-H3 hypotheses, constructing the following mechanism testing model:

$$M_{i,t} = \beta_0 + \beta_1 \text{ESG}_{i,t} + \sum \beta_j \text{Controls}_{i,t} + \mu_t + \lambda_t + \varepsilon_{i,t} \quad (5)$$

Where:M is a mechanism variable, denoting financing constraints, ethical culture of the firm, and level of innovation, respectively, and the other meanings are consistent with model (4).

4. Empirical testing and results analysis

4.1. Benchmark regression results

As shown in Table3, this paper examines the impact of corporate ESG performance on financial risk through benchmark regression. Column (1) does not consider any control variables, only controls the firm and year fixed effects. Column (2) is the result of adding control variables at the enterprise level on the basis of Column (1). Column (3) is the result of adding the control variable of GDP Growth at the regional level on the basis of column (2). To sum up, columns (1) to (3) show that the coefficient of ESG is significant and positive at the level of 1 %, which indicates that the performance of enterprise ESG has a significant positive effect on Z Score. This verifies Hypothesis H1: Good ESG performance is conducive to reducing corporate financial risks.

Table 3. Benchmark regression results

	(1)	(2)	(3)
Variables	Z value	Z value	Z value
ESG	0.338***	0.457***	0.459***
	(9.025)	(12.154)	-12.08
Cash-flow		2.930***	2.929***
		(4.095)	-4.095
Lez		-11.789***	-11.817***
		(-21.503)	(-21.231)
ROA		3.001**	2.967**
		(2.03)	-2.009
Fixed		-1.885***	-1.872***
		(-2.998)	(-2.969)
Asset-Growth		-0.019*	-0.019*
		(-1.907)	(-1.912)
Growth		0.000***	0.000***
		(2.94)	-2.936
Size		-1.078***	-1.081***
		(-10.219)	(-10.304)
Firm-Age		1.025***	1.041***
		(3.454)	-3.473
Dual		-0.196**	-0.191*
		(-2.006)	(-1.960)
Top1		-0.021***	-0.021***
		(-3.425)	(-3.395)
Board		-0.065	-0.063
		(-1.539)	(-1.518)
Indep		0.098	0.128
		(0.100)	-0.13
SOE		0.197	0.194
		(0.378)	-0.372
GDP-Growth			-1.796
			(-0.837)
Constant	3.918***	30.046***	47.863**
	(27.206)	(11.714)	-2.293
Firm Fixed Effect	Y	Y	Y
Year Fixed Effect	Y	Y	Y
N	34,901	34,901	34,901
R^2	0.543	0.594	0.594

Note: The robust standard deviation is expressed in parentheses: *, * *, * * * are significant at the 10 %, 5 %, and 1 % levels, respectively. The following tables are the same as above.

4.2. Robustness test

4.2.1. Replace the explained variable

Based on the existing research, the O-Score model is used to replace the explained variables for robustness testing. It is improved on the basis of the Z-Score model.

The calculation formula of O-Score model is as follows:

$$\begin{aligned} \mathrm{O-Score} = {} & -1.32 - 0.407\mathrm{SIZE} + 6.03\mathrm{TLTA} - 1.43\mathrm{WCTA} + 0.0757\mathrm{CLCA} \\ & -2.37\mathrm{NITA} - 1.83\mathrm{FUTL} + 0.2851\mathrm{INTWO} - 1.72\mathrm{OEEG} \\ & -0.521(\mathrm{NI_t} - \mathrm{NI_{t-1}})/(|NI_t| + |\mathrm{NI_{t-1}}| \end{aligned} \quad (6)$$

Where, SIZE = Ln (total assets); TLTA = total liabilities / total assets; WCTA = working capital / total assets; CLCA = current liabilities / total liabilities; if the net profit of the past two years is negative, then INTWO = 1, otherwise it is 0; if total liabilities > total assets, then OENEG = 1, otherwise 0; NI represents net profit. The larger the O-Score value, the smaller the financial risk.

The robustness test results are shown in column (1)of Table4. In the O-Score model, the regression coefficient of ESG performance and O-Score is -0.892, which is significantly negative at the 8% level. It shows that the better the ESG performance, the smaller the financial risk of the sample enterprises, which further supports Hypothesis H1.

4.2.2. Change the sample period

From the perspective of the development process of China 's ESG policy, the end of the 20th century-2015 is the embryonic period of ESG policy, which is mainly reflected in China 's ' environment ' oriented information disclosure policy layout; 2016-2020 is the exploration period of ESG policy. China 's ESG practice has officially entered the development model of " central modern environmental governance system construction+market ESG theory application ".

The sample period selected above is 2010-2022. In order to further prove the results, using the method of adjusted sample times by shortening the time window[11]. The data between 11-15 years and 16-20 years are eliminated respectively, and the remaining effective observation sample size is used to re-regression. The results are shown in columns (2) and (3) of Table4.

According to the results of the robustness test, the results of model 1 show that the regression coefficient of ESG performance and corporate financial risk is 0.441, which is significant at the 4 % level; the results of the second model show that the regression coefficient of ESG performance and corporate financial risk is 0.410, which is significant at the 4 % level.

Table 4. Robustness test

	(1)	(2)	(3)
	O value	Z value	Z value
ESG	-0.892***	0.441***	0.410***
	(-49.540)	(10.790)	(7.540)
Constant	25.800***	75.668*	43.748***
	(20.140)	(1.830)	(2.740)
control	Y	Y	Y
Firm Fixed Effect	Y	Y	Y
Year Fixed Effect	Y	Y	Y
N	36,435	25,359	20,295
R^2	0.554	0.658	0.654

4.3. Endogeneity test

In reference to Yu Guomeng' s research[12], in order to control the two-way causal problem between ESG performance and financial risk, this paper re-returns the Z Score and the ESG of one-period lag. Columns (1) and (2) in Table5 show that good ESG performance can significantly increase the Z value, H1 is proved.

For the purpose of further alleviating the endogeneity problem, this paper uses the instrumental variable method to test the endogeneity of the main conclusions. Based on the research results, this paper selects the average ESG score (IV1) and the one-period lagging ESG score (IV2) of the same city enterprises as the instrumental variables. On the one hand, the above two are highly correlated with explaining variables and meet the correlation requirements; on the other hand, the average ESG score of the same city enterprise in the same year will not directly affect the Z value and financial risk of the enterprise. The ESG score of the lagging period is not related to the current disturbance term in the model, which meets the exogenous requirements. Columns (3) and (4) in Table4 show the regression results. From column (3), it can be seen that ESG performance has the urban 'peer' effect, that is, the ESG performance of enterprises in the same city will have a positive impact on the ESG performance of other enterprises; the results of column (4) show that the regression coefficient of ESG is significantly positive at the level of 5%, indicating that after using instrumental variables method to control related endogenous problems, ESG performance still has a significant positive effect on Z score, that is, good ESG performance is conducive to reducing financial risk, assuming that H1 is proved again.

Table 5. Endogeneity test

Variable	(1)	(2)	(3)	(4)
	Explanatory variable lags one period	Explained variable lags one period	IV method	
	Z value	One-period lagging Z value	ESG	Z value
One-period lagging ESG	0.245***			
	(6.354)			
ESG		0.217***		0.230**
		(3.300)		(2.300)
IV1			0.410***	
			(54.030)	
IV2			0.543***	
			(38.400)	
Constant	54.865**	45.037*	-2.113***	29.209***
	(2.042)	(1.768)	(-10.680)	(9.680)
Control	Y	Y	Y	Y
Firm Fixed Effect	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y
N	29,639	29,639	30,183	30,183
R^2	0.629	0.573		0.264

4.4. Mechanism test

4.4.1. Financing constraints

This paper uses the WW index to measure corporate financing constraints,it is positively related to financial risk. Column (1) of Table6 shows that ESG performance can significantly increase the Z value, thereby reducing financial risk, which is consistent with the previous research conclusions. The regression coefficient of ESG in Column (2) is 0.006, which is significant and negative at the level of 1 %. This shows that ESG performance has a significant negative impact on the WW index, that is, the degree of corporate financing constraints is alleviated. Referring to the research results of Zuo Yanwei[13], the stronger the financing constraints of enterprises are, the greater the financial risk. Therefore, ESG performance reduces corporate financial risk by easing financing constraints, assuming that H2 is certified. The reasons are as follows: Investors will require companies with imperfect information disclosure of ESG to pay additional capital costs when investing in them, so as to compensate them for the additional risks caused by information asymmetry. Therefore, good ESG performance can reduce the information risk borne by investors,better protect the interests of investors, thereby reducing the capital cost that investors require enterprises to pay, reducing the degree of financing constraints of enterprises, and finally reducing the financial risk of enterprises.

4.4.2. Ethical culture mechanism

Corporate ethical culture is measured by the number of penalties reported by the CSRC in the year, that is, corporate violations. The regression analysis of H3 is carried out according to the mechanism test model (5). The regression results are shown in Column (2) of Table6. The regression coefficient between ESG performance and corporate violations is -0.082, which is significantly negative at the 1% level, indicating that strengthening ESG performance can enhance corporate ethical culture, assuming that H3 is verified. The reason behind this is that businesses focus on cultivation and promotion of corporate ethics culture, which can improve the quality of enterprise management personnel and increase their experience in controlling deviations and dealing with sudden crisis events[14]. When organizations strengthen their ethical culture, minimize infractions, project positive image to the public,it not only boosts their resilience against external risks but also sends encouraging messages to investors. This, in turn, increases investment in the organizations, enhances their financial management capabilities and capital flow, thereby lowering financial risks significantly.

4.4.3. Innovation mechanism

The enterprise innovation mechanism is quantified using two measures: the number of patent applications and the number of patents actually owned. The natural logarithm of the two numbers of patents is then added to one for each of them.The regression analysis of hypothesis H4 was conducted according to the mechanism test model (5), and the regression results are shown in Table 6(3)(4).The regression coefficient between ESG performance and the number of patent applications is 0.1093, which is significant at the 1% level; and the regression coefficient between ESG performance and the number of patents actually owned is 0.1215, which is significant at the 1% level, indicating that strengthening ESG performance can increase the number of patents owned by enterprises. The regression coefficient between ESG performance and the number of patents actually owned is 0.1215, which is significant at the 1% level.

This indicates that strengthening ESG performance can increase the number of patents owned by enterprises. This, in turn, indicates that ESG performance can enhance the level of innovation of enterprises, thereby verifying Hypothesis H4. The reasons are as follows: Corporate innovation brings distinctive resources, boosts competitive advantage, enhances the quality of products and services, fosters customer loyalty, increases repeat purchase rates, thereby boosting profitability and mitigating financial risks. In the age of big data, innovation can also unlock online sales channels, enhance customer interaction, offer precision services, and improve the efficacy of fulfilling social responsibilities.Concurrently, companies fortify data security and privacy in online marketing, bolster safeguarding of core assets, drive corporate growth, and mitigate financial risks[9].

Table 6. Mechanism of action test results

	(1)	(2)	(3)	(4)
Mechanism variables	Financing constraints	Ethical culture mechanism	Innovation level	
Variables	WW Index	Violated	Patent-applied	Patent-owned
ESG	-0.006***	-0.082***	0.122***	0.109***
	(-3.677)	(-14.172)	(14.415)	(13.472)
Constant	2.133***	1.916*	-12.232***	-11.660***
	(9.111)	(1.826)	(-33.012)	(-32.217)
Control	Y	Y	Y	Y
Firm Fixed Effect	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y
N	34,901	35,686	35,292	35,292
R^2	1.000	0.212	0.579	0.582

4.5. Heterogeneity analysis

4.5.1. Ownership nature

The impact of ESG performance on financial risk can vary based on ownership structure. State-owned enterprises, with dual identities of 'government and business', prioritize implementing national economic policies over profitability. They tend to focus on policy compliance for ESG investments. In contrast, non-state-owned enterprises are more profit-driven, often increasing investments in ESG to enhance profitability,and reduce risks. As a result, the impact of ESG performance on financial risk reduction is more pronounced in non-state-owned enterprises.

Based on the above analysis, this paper divides the sample companies into two groups: state-owned enterprises and non-state-owned enterprises according to the ownership nature, and conducts group regression on the impact of ESG performance on financial risk. The regression results are shown in columns (1) and (2) in Table7. It can be found that whether it is a state-owned enterprise (SOE=1) or a non-state-owned enterprise (SOE=0), the regression coefficient of ESG is significantly positive at the level of 1%, which is consistent with the previous conclusion of H1. However, the ESG regression coefficient of the non-state-owned enterprise is greater than the ESG regression coefficient of the state-owned enterprise. Therefore, compared with the state-owned enterprise, the ESG performance of the non-state-owned enterprise has a stronger positive effect on the Z Score, that is, it has a stronger effect on reducing financial risk. In summary, the reducing effect of ESG performance on financial risk is stronger in non-state-owned enterprises.

4.5.2. Enterprise scale attribute

Enterprises at different stages of development will differ in terms of business direction and economic strength. Generally speaking, large-scale enterprises have experienced longer development time than small-scale enterprises, have accumulated more experience in improving ESG performance. With the improvement of ESG performance, the reduction of corporate financial risk may have a marginal diminishing effect. But,when small-scale enterprises pay more attention to ESG performance, they can help enterprises gain the recognition and trust of stakeholders,improving financial robustness, and enhancing the ability to resist financial risks. Therefore, ESG can be expected to play a more risk-reducing role in small-scale enterprises[15].

In the existing data, the natural logarithm of total assets is used to measure the size of enterprises. The median of enterprise size is 21.917 as the boundary. Enterprises above the median are divided into large enterprises, and less than or equal to the median are divided into small enterprises. According to the size of different enterprises, the regression model is re-grouped, and the results are shown in Table7(3)(4). The regression coefficient of ESG performance and corporate financial risk (Z value) of small-scale enterprises is 0.539, which is significant at the 5% level. The regression

coefficient of ESG performance and corporate financial risk of large-scale enterprises is 0.1787, which is significant at the 1% level. ESG performance of small-scale enterprises has a stronger effect on reducing corporate financial risks, which is consistent with the above expectations.

4.5.3. Regional Properties

Due to the geographic variations in economic development levels and institutional environments, there are distinct heterogeneous attributes in ESG performance and financial risks. The eastern region, which exhibits relatively higher economic development levels than western region, typically adheres to stricter ESG standards due to its heightened vulnerability to environmental, social, and governance influences, potentially resulting in higher ESG standards compared to the West, leading to a lead in ESG performance. Consequently, companies in the eastern region are more likely to excel in ESG performance, thereby mitigating financial risks more effectively.

Based on the above analysis, this paper refers to the National Bureau of Statistics division standard and divides the regression analysis into east and west regions according to the region where the enterprises are registered. The regression results are demonstrated in (5)(6) in Table7, which show that the regression coefficients of ESG in the eastern and western regions are both significant at the 1% level, indicating that the ESG performance in both the eastern and western regions reduces the financial risk of enterprises, and the regression coefficients in the eastern region are larger than those in the western region, suggesting that the ESG performance in the eastern region has a greater degree of influence on the financial risk of enterprises.

Table 7. Heterogeneity regression results

	(1)	(2)	(3)	(4)	(5)	(6)
	State-owned enterprises	Non-state-owned enterprises	Small-scale enterprises	Large-scale enterprises	West	East
Variables	Z value	Z value	Z value	Z value	Z value	Z value
ESG	0.289***	0.376***	0.540***	0.179***	0.483***	0.408***
	(5.840)	(10.250)	(7.846)	(7.022)	(10.370)	(6.350)
Constant	28.344***	25.625***	9.089**	5.152***	100.806	35.240***
	(14.670)	(14.040)	(2.414)	(8.952)	(1.560)	(3.430)
Control	Y	Y	Y	Y	Y	Y
Firm Fixed Effect	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
N	12,510	22,789	16,876	18,388	25,478	9,652
R^2	0.228	0.286	0.578	0.802	0.584	0.635

5. Conclusions and Outlook

In light of the growing recognition of the significance of sustainable green development, the ESG performance of companies has attracted considerable interest from a diverse range of stakeholders. This study employs the annual data of China's A-share listed companies from 2010 to 2022 as the research sample to empirically explore the correlation between corporate ESG performance and financial risk, as well as the mechanisms through which this correlation is influenced. The findings indicate that there is a positive correlation between strong corporate ESG performance and a reduction in financial risk. This is achieved primarily through three mechanisms: easing financing constraints, enhancing ethical corporate culture, and elevating innovation levels. Thirdly, the heterogeneity test indicates that the positive impact of good ESG performance on reducing financial risk is more pronounced for non-state-owned enterprises, small-sized enterprises, and those situated in the eastern region. the increasing emphasis on the importance of sustainable green development, the ESG performance of companies has garnered significant attention from diverse stakeholders. By using the

annual data of China's A-share listed companies from 2010 to 2022 as the research sample, this study empirically explores the correlation between corporate ESG performance and financial risk along with its influencing mechanisms. The findings reveal that: firstly, strong corporate ESG performance contributes to decreasing corporate financial risk; secondly, companies primarily mitigate financial risk by easing financing constraints, enhancing their ethical corporate culture, and elevating their innovation level. Thirdly, the heterogeneity test confirms that the positive impact of good ESG performance on reducing financial risk is more pronounced for non-state-owned enterprises, small-sized enterprises, and those situated in the eastern region.

Drawing from these conclusions, the ensuing recommendations are proposed: From the internal level, enterprises should make use of good ESG performance to ease financing constraints, improve the reputation and image among investors, optimize financing structure, and at the same time pay attention to the construction of corporate ethics and culture and innovation investment, so as to enhance the competitiveness and ability to resist risks. From the external level of enterprises, investors should incorporate ESG performance into the investment decision framework, focus on eastern enterprises and small enterprises with outstanding performance in ESG. From the perspective of the government, establishing a sound system of intellectual property protection, intensify the infringement of intellectual property rights, protection of small-scale enterprise innovation, and by giving tax breaks and other preferential policies, attract more non-state-owned enterprises in ESG practice, thus form the whole society to promote the development of green.

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