ESG performance, risk-taking and corporate productivity: Blessing in disguise

Abstract: Corporate environmental, social and governance (ESG) is vital for socially sustainable growth, while corporate ESG engagement reflects the balance of choice between short-term and long-term interests. This study attempts to investigate the impact of ESG performance on corporate risk-taking capability and its subsequent effects on corporate productivity. Using data from Chinese listed companies from 2009 to 2020 and employing a multiple linear regression model, we find that corporate ESG performance can significantly reduce corporate risk-taking capacity. Further, we find regional green innovation level and environmental regulation can significantly strengthen the impact of ESG performance. Finally, it is found that corporate ESG performance can effectively increase corporate total factor productivity through the corporate risk-taking path. Our study provides a more comprehensive and complete understanding of the balance between sustainable growth and corporate risk-taking in an optimistic way, which is particularly important for corporate managers and policymakers of governments.

Keywords: ESG, corporate risk-taking, green innovation, environmental regulation

1. Introduction

Environmental degradation, climate change, and the depletion of natural resources present significant challenges to the long-term sustainable development of human society. It suggests that existing linear business models may not support corresponding sustainability objectives (Chin et al., 2022). ESG, an evaluation metric and responsible investment concept focused on non-financial performance, aims to promote the overall sustainable development of industries by strengthening corporate environmental consciousness, urging managers to fulfil social responsibilities, and improving internal governance mechanisms. ESG evaluates corporate sustainability and its impact on societal values from three dimensions: environment, social, and corporate governance.

Its ratings effectively reflect whether a company's commitment, performance, business model, and structure align with sustainability objectives (Pastor et al., 2021).

Enterprises are normally expected to balance promoting sustainable social development and maximising their interests, which will alter their strategies, risk-taking levels, and performance accordingly. Corporate risk-taking, as a manifestation of decision-making willingness in actual operation, indicates a company's investment inclination when facing uncertain external economic conditions and has significant implications for production efficiency. However, the current impact of corporate ESG performance on risk-taking remains unclear. Research generally believes that high levels of risk-taking can accelerate capital accumulation and increase firm value (Ferris et al., 2017). Nevertheless, in the actual operation of the socio-economic system, the relationship between risk-taking and firm value is not always a simple linear one. Investment decisions, innovation capacity, external compliance, and long-term strategy significantly influence the economic consequences of corporate risk-taking. Excessive risk-taking is not conducive to corporate growth and may lead to a shorter debt maturity structure, resulting in certain negative effects (Djembissi, 2011).

The proposal of the concept of sustainable development presents new evaluation criteria for assessing corporate risk and value. Existing research primarily examines the factors affecting a corporation's risk-bearing capacity from an internal perspective, neglecting the consideration of ESG in the context of the new era. The original risk-bearing capacity of a corporation does not necessarily align with its long-term value under the ESG framework. ESG reporting can enhance external investors' understanding of a company's environmental, social, and governance value information (Pedersen et al., 2021). For a corporation's ESG practices, this can be achieved by incorporating ecological and social responsibility into strategic business choices, including investment willingness and decision-making in the face of uncertainty (Lokuwaduge and Heenetigala, 2017; Yu et al., 2018). Therefore, the impact of ESG performance on corporate risk-bearing capacity requires examination.

It has been well noticed that an extremely limited body of literature has begun to explore the correlation between ESG performance and corporate risk-bearing capacity.

Building upon the foundation of agency theory by considering additional external supervision, He et al. (2023) put forward that ESG participation offers an insurance-like effect, yielding benefits to social reputation and representing an investment in social capital (He et al., 2023). However, as it may displace financial resources and squeeze out business resources, this could decrease a corporation's risk-bearing capacity. Although this perspective considers external environments and regulatory systems, it ultimately returns to a focus on a company's financial resources. This explanation overlooks the inherent motivation of corporations to actively choose to avoid high-risk investments that may potentially harm environmental governance due to conflicts with the ESG framework. Existing research does not sufficiently reveal the essential impact of ESG performance on corporate risk-bearing capacity, further reflected in the lack of examination of its economic outcomes. Therefore, the conclusions and implications embrace a sceptical and cautious attitude towards ESG participation. In contrast, our research provides a different explanation. We employ stakeholder theory, which emphasises the careful consideration of multiple parties' interests, to offer a complete examination and response to how ESG performance affects corporate risk-bearing capacity and the resulting economic outcomes.

Our research examines the impact of corporate ESG (Environmental, Social, and Governance) performance on business operational risk. In the foundational analysis, we conducted a statistical examination of Chinese-listed company samples from 2009 to 2020, investigating the effects of corporate ESG performance on business operational risk and examining the moderating effects of regional green innovation levels and external environmental regulation. Furthermore, we assessed the effects of ESG performance on total factor productivity by influencing corporate risk-bearing capacity.

The contributions of this study are primarily reflected in the following aspects: First, based on the perspective of corporate ESG practices, we expand the research on microeconomic agents within an ecosystem-oriented business model. By capturing the impact and mechanism pathways of corporate ESG performance on the governance of corporate externalities, we effectively enrich the relevant research on corporate strategic management (Rahmati et al., 2021; Chin et al., 2022). Second, our research

contributes to systematically understanding ESG practices and performance among Chinese listed companies. By constructing an analytical framework for corporate business models that incorporates administrative intervention and urban resource impacts, we supplement the existing theoretical literature on institutional domains from a horizontal perspective (Dacin et al., 2007; Peng et al., 2008). Third, we provide ample empirical evidence from emerging countries by combining China's unique institutional environment and using Chinese listed companies as samples for research design.

The remainder of this paper is structured as follows: Section 2 presents the theoretical framework and research hypotheses. Section 3 covers data and descriptive statistics. Section 4 discusses the empirical results. Section 5 provides further analysis of the economic consequences. Section 6 presents the analysis and discussion of the empirical results. Finally, section 7 concludes the study and highlights the practical implications.

2. Theory and hypothesis development

Existing research predominantly adopts agency theory to analyse the factors affecting corporate risk-bearing from an internal perspective, suggesting that corporate governance and managerial characteristics are important internal factors influencing corporate risk-bearing capacity (Hayes et al., 2012; Koerniadi et al., 2014). For instance, Liu and Mauer (2011) argue that compensation incentives can help managers overcome risk aversion and opt for relatively aggressive risk investments. A minority of studies propose that diversified institutional investors can disperse corporate risk, promote investment resilience, and consequently encourage corporate risk-bearing to vary degrees (Faccio et al., 2011; John et al., 2008).

ESG is a concept that balances the short-term and long-term interests of societal development. Corporate ESG reporting constitutes non-financial information that reflects both internal governance and external investors' understanding and support for a company's environmental, social, and governance value information (Pedersen et al., 2021). Therefore, a theory that combines the perspectives of multiple stakeholders, i.e., stakeholder theory, can better explain the relationship between corporate ESG performance, corporate risk-bearing capacity, and economic outcomes. Furthermore,

local policy systems and external factors influence corporate risk-bearing levels (Acharya et al., 2011; Arif and Lee, 2014; Mclean and Zhao, 2014). Based on these considerations, this study adopts both stakeholder theory and institutional factor theory.

2.1 ESG performance and corporate risk-taking

Corporate risk-bearing capacity refers to the ability of a company to cope with and withstand various uncertainties and potential losses through its own financial strength, management capabilities, and market competitiveness. The primary focus tends to be on short-term financial investment capabilities. For example, Lumpkin and Dess (1996) define corporate risk-bearing as the generalised cost companies are willing to pay to pursue high profits. However, ESG (Environmental, Social, and Governance) performance, as an essential indicator for assessing corporate performance in sustainable development and responsible operation, emphasises the long-term value of social development. The impact of the ESG framework on corporate risk-bearing capacity manifests in multiple aspects, including shareholder interests, customer satisfaction, regulatory compliance, and social reputation. Consequently, the influence of ESG performance on corporate risk-bearing capacity might be diverse and complex.

Stakeholder theory posits that corporate managers should not only focus on shareholder interests but also fully understand the needs of stakeholders. Managers should strategically balance multiple stakeholders' benefits to maximise interests in a generalised objective function (Freeman, 1984). Using stakeholder theory, we can analyse the potential impact of ESG performance on corporate risk-bearing capacity from the perspectives of different stakeholders. As market competitors, companies typically aim to maximise corporate net income and shareholder value (Friedman, 1970). Under this business logic, internal resources tend to be excessively skewed towards high-risk, high-reward projects, which may damage the benefits of other stakeholders. Conversely, when a company over-invests in risky projects, stakeholders may demand that resources be allocated more efficiently to other areas, such as the ecological environment and social responsibility. Therefore, corporate ESG performance can re-balance the resource allocation between investment and non-investment stakeholders and reduce corporate risk-bearing (Harjoto and Laksmana,

2018).

Firstly, ESG initiatives may impose short-term financial pressure on companies. Implementing ESG measures may require substantial upfront investments, including resources, infrastructure, and technology. This short-term financial pressure may reduce a company's financial resources, directly diminishing its investment capabilities and, consequently, its risk-bearing capacity. In another scenario, the emergence of the ESG framework increases the uncertainty of corporate investments, particularly in potentially high-polluting projects. When faced with investment projects that could potentially damage the environment in the future, even if such projects may bring high returns, companies may reduce their investment willingness due to the restrictions of the ESG framework. As a result, their risk-bearing capacity also declines correspondingly. Secondly, ESG initiatives may generate compliance costs and complexities: adhering to high ESG performance standards may increase the complexity of business operations and regulatory compliance. This additional complexity and associated costs may constrain a company's risk-bearing capacity, especially for resource-limited small enterprises. In this situation, regulatory authorities and other stakeholders may exert additional pressure on companies. Thirdly, in some cases, conflicts of interest may arise between stakeholders, leading to a dilemma for companies in balancing ESG performance with other objectives. For example, reducing environmental impact may increase customer costs or reduce shareholder returns. This potential conflict of interests may limit a company's ability to undertake risks while maintaining high ESG performance.

In summary, ESG can serve as an influencing factor to adjust the unequal distribution of internal resources within a company, thereby compensating for the needs of non-investment stakeholders (Mason and Simmons, 2014). This suggests that internalising the ecological environment and social responsibility in corporate ESG practices can help companies achieve sustainable development in ecological business models (Lokuwaduge and Heenetigala, 2017; Yu et al., 2018). ESG can incorporate ecological environment and social responsibility into a company's strategic planning and meet the corresponding needs of stakeholders such as local governments and

corporate customers. However, these demands for long-term value may come at the cost of reducing a company's ability to bear environmentally harmful risks. Therefore, it is proposed that the following:

Hypothesis 1: ESG rating performance decreases the risk-taking level of the firm.

2.2. The moderation role of regional green innovation level

As an important component of ESG practices, corporate green innovation can effectively respond to ecological and environmental responsibility and social performance (Kraus et al., 2020; Chin et al., 2022). Although corporate innovation usually requires long R&D cycles and is accompanied by unpredictable R&D risks (Holmstrom, 1989), according to stakeholder theory, companies can gain a good reputation and competitive advantage in the market through R&D investment in green technologies and further gain stakeholder support (Huang and Li, 2015; Singh et al., 2020). Meanwhile, according to resource dependence theory, when stakeholders have positive expectations for the firm's development, they are more willing to provide critical external resources (Frooman, 1999; Backhaus et al., 2002). Further, for the influence effect of external green innovation resources, regions with strong eco-innovation capabilities have more mature basic applied research and supporting carrier construction, which can create a "siphon effect" of advanced technology and human capital. It provides an important external resource environment for companies to strengthen their ESG practices. In particular, the mature development of external collaborative innovation mechanisms enables the diffusion and transfer of knowledge and technology elements among the main bodies of industry, academia and research. The spillover effect of external green innovation can help enterprises to make a certain degree of adjustment to the resource inclination of high-risk innovation projects. Therefore, it is proposed that:

Hypothesis 2: Regional green innovation level strengthens the effects of corporate ESG performance on the corporate risk-taking level.

2.3. The moderation role of regional environmental regulation

The institutional theory focuses on the interaction between institutions and organisations and emphasises the influence of external environmental systems on firm

behaviour (Scott, 1995; Dacin et al., 2007; Penget al., 2008). According to stakeholder theory, there are endogenous drivers for corporate ESG practices to consider other stakeholders, which include government departments (Freeman, 1984). Therefore, when local governments assign formal or informal ecological requirements to firms, firms usually form sustainable development goals consistent with local governments. Based on the above theory, we include the external institutional requirements of local governments, i.e., regional environmental regulations, in the analytical framework of regulatory effects.

In general, strict environmental regulations exacerbate firms' risk concerns, leading to a negative relationship between firms' environmental management performance and business risks (Xue et al., 2020). Further, firms with good ESG performance place no less importance on ecological and social performance than on normal economic returns to the firm (Kohtamäki et al., 2020). It leads to stronger drivers of environmental benefits for firms in general in the presence of regional environmental regulation (Song et al., 2022). For example, external environmental constraints increase firms' willingness to innovate and promote the green transformation of production processes (Fabrizi et al., 2018; Jiang et al., 2020). It effectively strengthens corporate's ESG practices and responds positively to ecological and social responsibility requirements (Peattie and Ratnayaka, 1992). Therefore, it is proposed that the following:

Hypothesis 3: Regional environmental regulation strengthens the effects of corporate ESG performance on the corporate risk-taking level.

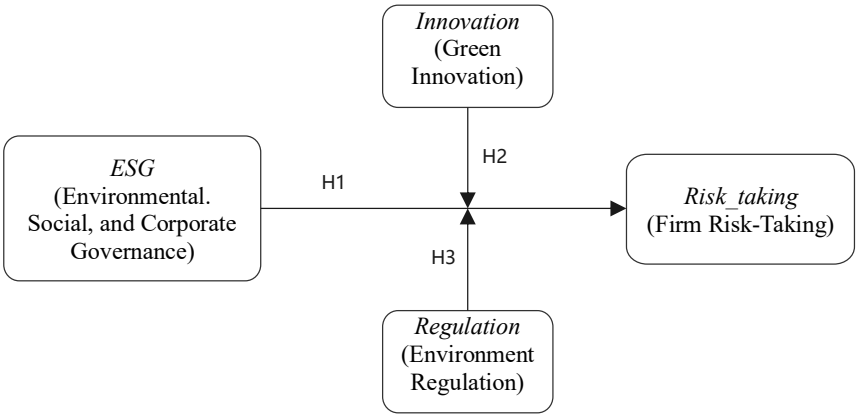

***Figure. 1**: The Theoretical Framework*

3. Data and descriptive statistics

3.1. Measurement methods

As a core policy tool to achieve the goal of carbon peaking and carbon neutrality, China's carbon emission trading market officially starts trading in 2021. This causes a certain degree of exogenous impact on the ESG indicator system, whose core connotation is green development. The relatively late year of the policy makes it impossible to capture the persistent policy effects in the study design, which can interfere with the initial results. Also, we consider the impact of the 2008 financial crisis on enterprises. Therefore, this paper selects the data of 3316 A-share listed enterprises from 2009 to 2020 as the initial research sample to examine the relationship between corporate ESG performance and corporate business risk. In addition, this paper excludes the sample data of the financial industry, the sample data of S.T. category listed enterprises within the sample period and the sample data of missing key variables, and finally obtain 20,238 annual observations of enterprises. Meanwhile, to avoid the influence of extreme values on the conclusions, all continuous variables are subjected to tail shrinking (Winsorize) at the 1% and 99% quartiles. The financial data of listed enterprises in this study are mainly obtained from the Wind database, CNRDS database, CSMAR database, annual reports of listed enterprises, and annual work reports of governments in China.

3.1.1. Risk-taking (*Risk_taking*)

Dependent variable. The volatility of corporate earnings is widely used as a measure of corporate risk-taking because higher risk-taking implies increased uncertainty about the future cash inflows of the firm. Therefore, this paper mainly uses corporate earnings volatility to measure business risk (John et al., 2008). Where corporate earnings ($ROA_{i,t}$) is the ratio of a firm's annual earnings before taxes, interest, depreciation and amortisation ($Ebitda_{i,t}$) to the total assets at the end of the year ($Assets_{i,t}$) at the end of the year. For earnings volatility, this paper first adjusts the firm's calendar year ROA adjusted using the industry mean difference, and then observes the adjusted earnings ($Adj\_ROA_{i,t}$) fluctuations over the window period. That is:

$$Risk\_taking_i = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(Adj\_ROA_{i,t} - \frac{1}{T}\sum_{t=1}^{T} Adj\_ROA_{i,t})^2} \text{ , T=3} \quad (1)$$

$$Adj\_ROA_{i,t} = \frac{Ebitda_{i,t}}{Assets_{i,t}} - \frac{1}{N_t}\sum_{k=1}^{N_t}\frac{Ebitda_{k,t}}{Assets_{k,t}} \quad (2)$$

3.1.2. ESG performance (*ESG*)

Independent variables. This paper uses the Huazheng ESG rating to measure the independent variable (*ESG*). The C, CC, CCC, B, B.B., BBB, A, A.A., and AAA ratings are quantitatively assigned as 1-9 in that order (Chen et al., 2022). As an early third-party data provider for ESG ratings in China, Huazheng Index is also a signatory of the United Nations Principles for Responsible Investment (UNPRI). Huazheng ESG index system refers to the mainstream international rating framework, incorporates evaluation indicators that fit the actual situation of China's capital market, and covers all A-share listed companies in China. Therefore, compared with the indicator systems of other rating agencies, Huazheng ESG data is more applicable to the empirical analysis of Chinese listed companies, and the conclusions obtained are more representative and reliable.

3.1.3. Green innovation (*Innovation*)

Common measures of regional innovation include regional R&D investment, the number of innovative talents and actual innovation patent output (Bendig et al., 2020; Song et al., 2015). According to the green list of international patent classifications introduced by the World Intellectual Property Organization (WIPO), this paper selects the number of green innovation patent applications in cities as a proxy indicator of regional green innovation (Li et al., 2022). In addition, to improve the model's validity, this paper converts the discrete data of the number of green patents into continuous data through the natural logarithm form, thus eliminating the problem of the right-skewed distribution of green patent data.

3.1.4. Environmental *regulation* (*Regulation*)

Common measures of regional environmental regulation include environmental pollution control R&D investment, carbon emissions, and climate concerns (Pan et al., 2019; Chen et al., 2022). However, although these indicators can reflect some aspects of regional environmental governance to varying degrees, they cannot accurately measure the full picture of local environmental governance policies. In particular, the Chinese government has a relatively large number of environmental governance instruments, including both economic instruments, such as increasing environmental R&D investment and regulating pollution tax rates, and legal and regulatory instruments, such as enacting environmental protection regulations, promulgating environmental protection rules and regulations, and even directly issuing administrative orders for energy conservation and emission reduction (Wang et al., 2018; Li et al., 2022). Therefore, to prepare to capture the full picture of regional environmental governance, this paper selects the word frequency statistics of local government work reports for environmental attention as a proxy variable for regional environmental regulation (Chen et al., 2016). This is mainly because the Chinese government work report is an outline for the administration and implementation of decisions and resolutions of power organs according to the law and is a programmatic document to guide the work of the government. Therefore, the frequency of environment-related terms and their proportion in the government work report can more comprehensively reflect the strength of local government environmental governance and the whole picture of government environmental governance policies.

3.1.5. Control variables

To improve the precision of the study, this paper captures firm characteristics by selecting a series of control variables, reducing the model bias brought about by omitted variables. First, the empirical model in this paper is chosen to control for firm structural characteristics. Referring to the research methods of Bird et al. (2018), Harjoto and Laksmana (2018), and Koirala et al. (2020), we add firm size (*Size*), firm staff (*Staff*), debt level (*Lev*), firm cashflow (*Cashflow*), firm growth (*Growth*), firm age (*FirmAge*) as important characteristics of firms in actual operation. Second, the empirical model is selected to control corporate governance characteristics further. The two-job

concurrency (*Dual*) and board size (*Board*) are added as management characteristics variables, respectively (Bird et al., 2018). In addition, referring to Hayes et al. (2012), and Koerniadi et al. (2014), the equity checks and balances (*Balance*) and executive shareholding (*Mshare*) are selected to measure corporate equity structure and equity incentives. Third, the empirical model in this paper also considers the capital market characteristics of firms. Referring to the research methods of Arif and Lee (2014), Habib and Hasan (2017), TobinQ (*TobinQ*), and average monthly excess turnover (*Dturn*) are selected to measure corporate investment demand and external investor sentiment. The main variables are defined as shown in Table 1.

Table 1 Definition and description of main variables

Variable Symbols	Variable Definition	Data source
(1)*Risk_taking*	Corporate earnings volatility	The initial variable data were obtained from the CSMAR database, and the formulae were calculated according to John et al. (2008).
(2)*ESG*	Corporate ESG rating performance.	Wind Database
(3)*Innovation*	Logarithmic value of the number of green patents in prefecture-level cities.	CNRDS Database
(4)*Regulation*	The frequency of environmental words in the text of prefecture-level government work.	Annual Report on the Work of Local Governments in China
(5)*Size*	is the natural logarithm of the enterprise's total assets at the end of the year.	CSMAR Database
(6)*Staff*	The logarithmic value of the number of employees in the company.	CSMAR Database
(7)*Lev*	is the ratio of total liabilities to total assets of the enterprise at the end of the year.	CSMAR Database
(8)*Cashflow*	The ratio of a firm's free cash flow to total assets.	CSMAR Database
(9)*Growth*	Business revenue growth rate.	CSMAR Database

(10)*Dual*	The positions of chairman and general manager of the company are combined as dummy variables.	CSMAR Database
(11)*TobinQ*	Enterprise market capitalisation to asset size ratio.	CSMAR Database
(12)*FirmAge*	Corporate age log value.	CSMAR Database
(13)*Board*	The total number of seats on the board of directors of the company.	CSMAR Database
(14)*Balance*	The ratio of the sum of the shareholdings of the second to fifth largest shareholders to the shareholding of the first largest shareholder.	CSMAR Database
(15)*Dturn*	The difference between the current year's average monthly stock turnover rate and last year's average monthly stock turnover rate.	CSMAR Database
(16)*Mshare*	The ratio of the total number of shares held by corporate executives to the total number of shares.	CSMAR Database

3.2. Descriptive statistics

Table 1 lists the definitions and data sources of the main variables involved in the study of this paper. Table 2 presents the Pearson correlation coefficient matrix and descriptive statistics results for the main variables in this paper. The coefficient matrix indicates that the correlation coefficients among the variables are within the acceptable range. Therefore, there is no serious issue of multicollinearity. The data results show that the minimum value of enterprise risk performance (*Risk_taking*) is 0.001, the maximum value is 0.173, and the sample standard deviation is as high as 0.031 relatives to the mean value of 0.026. It indicates a large individual variation during the sample observation period, which can provide a better research sample for analysing corporate risk performance and its influencing factors in this paper. The independent variable ESG performance (*ESG*) has a minimum value of 1.000, a maximum value of 9.000, a mean value of 6.551, and a sample standard deviation of 1.041. green innovation (*Innovation*) *is a city-level* moderating variable with a minimum value of 0.000, a maximum value of 10.088, a mean value of 6.772, and a sample standard deviation of

1.948. environmental regulation (*Regulation*) is a city-level moderating variable with a minimum value of 0.000, a maximum value of 10.088, a mean value of 6.772, and a sample standard deviation of 1.948. The minimum value of *Regulation* is 0.000, the maximum value is 0.018, the mean value is 0.006, and the sample standard deviation is 0.002. Due to space limitations, the typical indicators of the control variables are shown in Table 2.

4. Empirical analysis and results

4.1. Model design

Drawing on Harjoto and Laksmana (2018) and Vural-Yavas (2020) research methods, this paper sets the following benchmark regression model and chooses to cluster to firm-level robustness criteria mistakenly to improve model robustness.

$$Risk\_taking_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \alpha \sum X_{i,t} + \mu_i + \delta_j \times \gamma_t + \varepsilon_{i,t} \quad (1)$$

$$Risk\_taking_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Modulate_{i,t} + \beta_3 ESG_{i,t} \times Modulate_{i,t} + \alpha \sum X_{i,t} + \mu_i + \delta_j \times \gamma_t + \varepsilon_{i,t} \quad (2)$$

In model (1), the $Risk\_taking_{i,t}$ is the dependent variable, which represents firm risk-taking; $ESG_{i,t}$ is the independent variable, representing the firm's ESG performance; $X_{i,t}$ is the series of control variables;μ_i is the firm fixed effect, which controls for differences in the firm's fixed characteristics; $\delta_j \times \gamma_t$ is the high-dimensional industry-time fixed effect, which controls for the variance of firms in the changing industry environment and further mitigates the disturbance bias caused by the missing variables;$\varepsilon_{i,t}$ is the random disturbance term. In the above model, this paper focuses on the coefficient β_1 which is the net effect of measuring the impact of corporate ESG performance on corporate risk-taking. If β_1 is significantly negative, indicating that corporate ESG performance can significantly mitigate the corporate risk-taking.

Table 2 Descriptive statistics of main variables

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Risk_taking	1.000															
ESG	-0.127***	1.000														
Innovation	0.049***	0.087***	1.000													
Regulation	0.041***	0.023***	0.154***	1.000												
Size	-0.135***	0.348***	0.096***	0.057***	1.000											
Staff	-0.137***	0.236***	-0.033***	0.020***	0.693***	1.000										
Lev	-0.067***	0.117***	-0.027***	-0.037***	0.520***	0.330***	1.000									
Cashflow	-0.066***	0.060***	-0.058***	-0.014*	0.035***	0.162***	-0.145***	1.000								
Growth	0.008	-0.036***	0.014**	0.008	0.058***	-0.003	0.052***	-0.007	1.000							
Dual	0.069***	-0.093***	0.079***	0.051***	-0.163***	-0.114***	-0.149***	-0.028***	0.025***	1.000						
TobinQ	0.128***	-0.109***	-0.005	0.018**	-0.418***	-0.297***	-0.268***	0.092***	-0.004	0.058***	1.000					
FirmAge	0.036***	0.090***	0.103***	0.079***	0.177***	0.029***	0.183***	-0.002	-0.016**	-0.096***	0.001	1.000				
Board	-0.105***	0.125***	-0.080***	-0.052***	0.262***	0.252***	0.175***	0.057***	-0.023***	-0.181***	-0.139***	0.023***	1.000			
Balance	0.110***	-0.042***	0.057***	0.045***	-0.095***	-0.077***	-0.154***	-0.016**	0.065***	0.062***	0.034***	-0.025***	0.006	1.000		
Dturn	0.009	0.066***	-0.060***	-0.037***	0.126***	0.091***	0.135***	0.043***	-0.040***	-0.087***	0.088***	0.100***	0.049***	-0.079***	1.000	
Mshare	0.069***	-0.137***	0.129***	0.061***	-0.319***	-0.207***	-0.334***	-0.028***	0.056***	0.254***	0.009	-0.267***	-0.203***	0.280***	-0.196***	1.000
Obs	20238	20238	19144	19064	20238	20238	20238	20238	20238	20238	20238	20238	20238	20238	20238	20238
Mean	0.026	6.551	6.772	0.006	22.112	7.659	0.429	0.044	0.203	0.253	2.105	2.786	2.144	0.683	-0.145	0.125
SD	0.031	1.041	1.948	0.002	1.261	1.299	0.206	0.071	0.473	0.435	1.412	0.365	0.198	0.596	0.505	0.197
Min	0.001	1.000	0.000	0.000	19.350	2.303	0.027	-0.224	-0.649	0.000	0.815	1.099	1.609	0.018	-2.494	0.000
Max	0.173	9.000	10.088	0.018	26.250	13.223	0.925	0.283	4.806	1.000	17.676	3.526	2.708	2.961	1.585	0.709

Model (2) is a moderating effect test model based on model (1) set-up. Where $Modulate_{i,t}$ is the moderating variable added in the mechanism analysis, and the moderating variable in this paper is selected as green innovation and environmental regulation at the city level. In model (2), the β_1 with β_2 is the direct effect. This paper focuses on β_3 , which is the moderating effect of measuring moderating variables acting on firm ESG performance on firm risk-taking. If β_3 is significantly positive, it indicates that regional green innovation and regional environmental regulation can positively enhance the mitigating effect of corporate ESG performance on corporate risk-taking. The remaining variable settings and coefficients are consistent with the model (1) settings.

4.2. Results of multiple regression analysis

The results of the benchmark regression are reported in the model(1) in Table 3, and hypothesis 1 is supported. It was found that after controlling for differences in firm characteristics with for industry-time high-dimensional fixed effects, firm ESG performance (*ESG*) showed a significant negative correlation with firm *Risk_taking* (β_1 =-0.001, P<0.01), which indicates that good ESG performance of firms can significantly reduce the risk profile of firms in actual operations.

The test results of the moderating effect of green innovation are reported in model (2) in Table 3, where hypothesis 2 is supported. The interaction term of regional green innovation (*ESG*×*innovation*) has a significant negative effect on firm risk-taking (*Risk_taking*) (β_3 = -0.001, P<0.01). It indicates that regional green innovation strengthens the negative effect of corporate ESG performance on corporate risk-taking.

The test results for the moderating effect of environmental regulation are reported in model(3) in Table 3. Hypothesis 3 is supported. The interaction term of regional environmental regulation (*ESG* × *Regulation*) has a significant negative effect on firm risk-taking (*Risk_taking*) (β_3 = -0.257, P<0.05). This indicates that regional environmental regulation (*Regulation*) strengthens the negative effect of corporate ESG performance on corporate risk-taking.

The results of the control variables show that the regression coefficient of firm growth (*Growth*) is -0.002, which is significant at the 1% statistical level. The

regression coefficient of executive shareholding (*Mshare*) is -0.018, which is significant at the 1% statistical level. The regression coefficient of (*Balance*) is 0.054, which is significant at 1% statistical level. The regression coefficient of debt (Lev) level is 0.014, which is significant at 1% statistical level. The regression coefficient of *T*obinQ (*TobinQ*) is 0.002, which is significant at the 1% statistical level. The regression coefficient of average monthly excess turnover (*Dturn*) is 0.002, which is significant at the 1% statistical level. The rest of the control variables are not statistically significant, probably due to the peculiarities of emerging economies and restricted sample size.

Table 3 Results of baseline regression and moderating effect tests

	(1)	(2)	(3)
VARIABLES	*Risk_taking*	*Risk_taking*	*Risk_taking*
ESG	-0.001***	0.003**	0.001
	(0.000)	(0.001)	(0.001)
Innovation		0.005***	
		(0.001)	
Regulation			1.635**
			(0.816)
ESG×innovation		-0.001***	
		(0.000)	
ESG×Regulation			-0.257**
			(0.117)
Size	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
ln_staff	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Lev	0.014***	0.014***	0.015***
	(0.004)	(0.004)	(0.004)
Cashflow	-0.005	-0.005	-0.005
	(0.004)	(0.004)	(0.004)
Growth	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)
Dual	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
TobinQ	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
FirmAge	0.002	0.001	0.001
	(0.005)	(0.006)	(0.006)
Board	-0.002	-0.001	-0.001

	(0.003)	(0.003)	(0.003)
Balance	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
Dturn	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Mshare	-0.018***	-0.018***	-0.019***
	(0.006)	(0.006)	(0.006)
Constant	0.006	-0.029	-0.003
	(0.028)	(0.031)	(0.030)
Firm	YES	YES	YES
Industry×Year	YES	YES	YES
Observations	19,744	18,697	18,617
R-squared	0.530	0.534	0.534

Note: N=3316 firms with 2009 to 2020.

Robust standard errors for clustering to the firm level in parentheses.

*** p<0.01,** p<0.05,* p<0.1.

4.3.Robustness test results

To avoid the bias of the results caused by how the independent variables are measured, this paper uses the Bloomberg ESG evaluation index as a proxy variable for robustness testing (McBrayer, 2018). The results are shown in model (1) of Table 4, where the proxy variable (*ESG_replace*) shows a significant negative correlation with corporate risk performance (*Risk_taking*) (β_1 =-0.0002, P<0.10). The regression results are generally consistent with the findings of the underlying study, and the benchmark regression results are robust.

The results of the robustness tests of the moderating effects are shown in models (2) and (3) in Table 4. The regional green innovation interaction term (*ESG_replace*×*innovation*) and the regional environmental regulation interaction term (*ESG_replace*×*Regulation*) both have a significant negative effect (β_3 = -0.0002, P<0.01; β_3 = -0.052, P<0.10). The regression results were generally consistent with the findings of the underlying study, and the regression results of the moderating effects were robust.

Table 4 Robustness test results

	(1)	(2)	(3)
VARIABLES	*Risk_taking*	*Risk_taking*	*Risk_taking*
ESG_replace	-0.0002*	0.001***	0.0001
	(0.0001)	(0.000)	(0.0002)
Innovation		0.005***	
		(0.002)	
Regulation			1.085
			(0.725)

ESG_replace×innovation		-0.0002***	
		(0.000)	
ESG_replace×Regulation			-0.052*
			(0.031)
Size	-0.003*	-0.003	-0.004*
	(0.002)	(0.002)	(0.002)
ln_staff	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Lev	0.017***	0.016**	0.017***
	(0.006)	(0.006)	(0.006)
Cashflow	-0.006	-0.006	-0.005
	(0.006)	(0.006)	(0.006)
Growth	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)
Dual	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)
TobinQ	0.001**	0.001**	0.001*
	(0.001)	(0.001)	(0.001)
FirmAge	-0.018**	-0.020***	-0.020***
	(0.007)	(0.007)	(0.007)
Board	-0.004	-0.004	-0.004
	(0.004)	(0.004)	(0.004)
Balance	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
Dturn	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Mshare	-0.009	-0.008	-0.009
	(0.011)	(0.011)	(0.011)
Constant	0.160***	0.124***	0.164***
	(0.046)	(0.047)	(0.047)
Firm	YES	YES	YES
Industry×Year	YES	YES	YES
Observations	6,900	6,585	6,557
R-squared	0.577	0.585	0.584

Robust standard errors for clustering to the firm level are in parentheses.

*** p<0.01,** p<0.05,* p<0.1.

4.4.Endogenous mitigation test results

Other potential factors may influence realistic corporate ESG practices, which may interfere with the experimental estimation results. Therefore, this paper uses the instrumental variables approach to mitigate the endogeneity problem. Model (1) and model (2) in Table 5 provide the regression results of the instrumental variables

approach in this paper, where the instrumental variables are selected as the intra-industry means of corporate ESG performance (El Ghoul et al., 2011; Attig et al., 2013). The results of the statistics indicate that the K-P LM statistic is significant at the 1% statistical level, rejecting the hypothesis of under-identification of instrumental variables. The K-P LM statistic exceeds the critical value of 10%, rejecting the hypothesis of weak instrumental variables. Thus, after mitigating the endogeneity of the benchmark model through the instrumental variables approach, the independent variable (ESG) remains significantly positive in the regression results, indicating that corporate ESG performance can significantly reduce the risk profile in actual corporate operations.

In addition, the relationship between the impact of corporate ESG performance on corporate risk profile is accurately identified to exclude the interference of other factors. This paper attempts to introduce ESG-related regulatory policies introduced in China as a quasi-natural experiment of external shocks to test the effect of ESG regulatory policies on corporate risk. Drawing on Nunn and Qian (2011) and Koirala et al. (2020), this paper uses a continuous double difference model in the context of a quasi-natural experiment to address possible endogeneity issues. In this paper, we take 2016 as the shock year of ESG regulatory policy[1] , set the policy dummy variable (*Policy*) and construct the explanatory variable (*DID=ESG×Policy*). *The* rest of the settings are consistent with the benchmark model. The interaction term (*DID*) reflects the impact of ESG regulatory policy shocks on firm risk. The test results are shown in model (3) of Table 5, where ESG regulatory policy (*DID*) shows a significant negative correlation with firm risk performance (*Risk_taking*) (β_1 = -0.003, P<0.10). The common trend

[1] In August 2016, the People's Bank of China, the Securities Regulatory Commission and seven other ministries and commissions jointly issued the "Guidance on Building a Green Financial System", which proposed to gradually establish and improve the mandatory environmental information disclosure system for listed companies. the guidelines on the content and format of annual reports of listed companies issued by the Securities Regulatory Commission in December 2016 require mandatory disclosure of environmental information by key emissions companies.

test of the double difference model was performed using the state of affairs study method, and the test results are shown in *Figure 2*.

Table 5 Results of endogeneity mitigation test

	(1)	(2)	(3)
VARIABLES	*ESG*	*Risk_taking*	*Risk_taking*
ESG_ind	0.617***		
	(0.045)		
ESG		-0.010***	
		(0.003)	
DID			-0.003***
			(0.000)
Size	0.045*	0.003**	0.003**
	0.027	(0.001)	(0.001)
ln_staff	0.099***	-0.000	-0.001
	0.020	(0.001)	(0.001)
Lev	-0.341***	0.012***	0.015***
	0.084	(0.004)	(0.004)
Cashflow	-0.146	-0.009**	-0.008**
	0.101	(0.004)	(0.004)
Growth	-0.050***	-0.003***	-0.003***
	0.012	(0.001)	(0.001)
Dual	-0.037	-0.000	0.000
	0.025	(0.001)	(0.001)
TobinQ	-0.016**	0.001***	0.001***
	0.008	(0.000)	(0.000)
FirmAge	-0.231*	0.005	0.007
	0.135	(0.005)	(0.005)
Board	0.036	-0.001	-0.001
	0.076	(0.003)	(0.003)
Balance	-0.041	0.004***	0.005***
	0.028	(0.001)	(0.001)
Dturn	0.008	0.003***	0.002***
	0.012	(0.000)	(0.000)
Mshare	0.490***	-0.018***	-0.021***
	0.111	(0.006)	(0.006)
Constant	-	-	-0.046*
	-	-	(0.027)
Firm	YES	YES	YES
Year	YES	YES	YES
Observations	19,795	19,795	20,238
F	188.66	11.99	22.42

R-squared	-	-	0.096
Underidentification test (K-P LM)	-	138.467	-
P(.)	-	(0.000)	-
Weak identification test (K-P LM)	-	188.664	-
IV size	-	(16.380) 10%	-

Robust standard errors for clustering to the firm level in parentheses.
*** p<0.01,** p<0.05,* p<0.1.

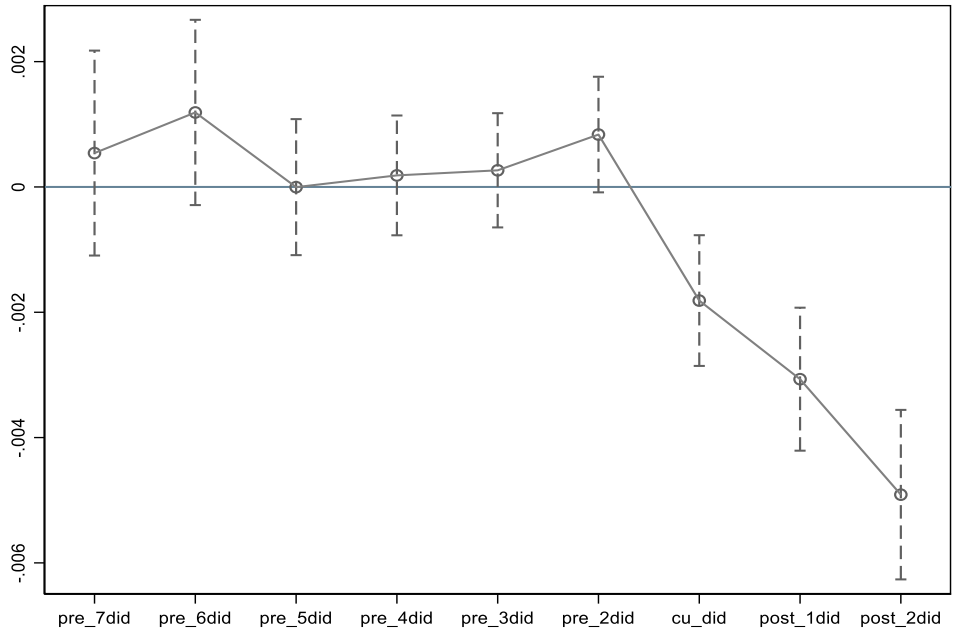

Figure. 2: The Common Trend Test

5. Further analysis

Total factor productivity (*TFP*), which is the increase in output due to technological progress beyond the input factors, is often regarded as the main driver of national economic growth and the core competitiveness of firms in the long run (Solow, 1957; Olley and Pakes, 1996; Levinsohn and Petrin, 2003). We analyse the role of corporate ESG performance on corporate total factor productivity based on three dimensions of ESG. First, for the environmental performance of firms, Porter's hypothesis suggests that firms can obtain higher technological productivity by improving their environmental performance (Porter, 1992; Jaffe and Palmer, 1997). Second, for corporate social responsibility, stakeholder theory suggests that good social performance of firms can send positive signals to local governments, investors, and the public, which in turn helps firms to gain support from various stakeholders. It helps to improve the productivity of the corporate (Deng et al., 2022). Third, for corporate governance, the loss of corporate management efficiency is detrimental to the rational allocation of production factors. Compared to firms with low managerial capacity, firms

with high managerial capacity have significantly higher productivity (Syverson, 2011). Therefore, corporate ESG performance can positively affect corporate productivity to some extent (Deng et al., 2022).

However, high levels of corporate risk-taking often exacerbate agency problems and thus negatively affect firms' total factor productivity. Based on principal-agent theory, when corporate risk-taking is at a high level, managers may, on the one hand, manipulate corporate surplus to conceal negative information, for example, to maximise their interests (Lambert et al., 1993). and Mauer, 2011). In addition, many risky projects in a firm can cause a certain degree of internal capital shortage, which can crowd out the output of non-productive factors (Liu and Mauer, 2011). Thus, corporate risk-taking is, to some extent, an important control mechanism affecting firms' productivity.

Based on the above analysis and benchmarking study hypotheses, corporate ESG performance can improve productivity by reducing corporate risk-taking.

We used a two-step regression system model and captured the mediating effects of risk-taking in corporate ESG practices by obtaining fitted values of corporate risk-taking and thus examining corporate productivity under the influence of ESG (Harjoto and Laksmana, 2018; Di Giuli and Paul, 2021; Fonseca, 2022). The model is set up as follows, with control variables selected in line with the benchmark model and the same choice of clustering to firm-level robust standard errors.

$$TFP_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \alpha \sum X_{i,t} + \mu_i + \delta_j \times \gamma_t + \varepsilon_{i,t} \quad (3)$$

$$TFP_{i,t} = \beta_0 + \beta_2 Risk\_\widehat{taking}_{i,t} + \alpha \sum X_{i,t} + \mu_i + \delta_j \times \gamma_t + \varepsilon_{i,t} \quad (4)$$

In model (3), the $TFP_{i,t}$ is the dependent variable, which represents the total factor productivity of the firm; $ESG_{i,t}$ is the independent variable, which represents the firm's ESG performance. In model (4), the $Risk\_\widehat{taking}_{i,t}$ is the mediating variable, representing the fitted value obtained from the benchmark model (1) to exclude the endogenous disturbance contained in the random disturbance term. In the above model, this paper focuses on the coefficient β_1 with β_2 . If β_1 is significantly positive and β_2 is significantly negative. It indicates that corporate ESG performance can enhance corporate total factor productivity through the corporate risk-taking path.

Firm total factor productivity (*TFP*) is estimated using the classical Levinsohn and Petrin (2003) L.P. estimation method with Olley and Pakes (1996) O.P. estimation method. Further, we constructed grouped dummy variables based on firm ESG performance and divided the experimental sample into two groups. Panel A in Table 6 reports the results of the test of variance for the (*TFP*) mean analysis. The significant

difference in results between groups provides a reliable premise for our subsequent two-step regression system model tests. The test results for further analysis are shown in Panel B in Table 6. In both model (1) and model (2), the coefficient of the independent variable (*ESG*) is 0.014, both of which are significantly positive at the 1% statistical level, which indicates that the ESG performance of enterprises has a significant positive effect on the total factor productivity of enterprises and can effectively improve the productivity of enterprises. In model (3) and model (4), the results of the second stage regression, the regression coefficients of the mediating variable (*Risk_taking*) are -14.132 and -14.659, respectively, both of which are significantly negative at the 5% statistical level. This indicates that corporate ESG performance can reduce the level of uncertainty in future cash inflows through the corporate risk-taking path, which in turn improves corporate total factor productivity.

Table 6 Test results for further analysis

Panel A: Differences in mean analysis of main variables				
	ESG (1)	*ESG* (2)	Difference (1)-(2)	
	Mean	Mean	Mean Diff	P-value
TFP_LP	8.054	8.631	-0.578	0.000***
TFP_OP	6.421	6.874	-0.454	0.000***
Observations	11,221	8,229	-	-
Panel B: The mediating effect test of risk-taking				
	(1)	(2)	(3)	(4)
VARIABLES	*TFP_LP*	*TFP_OP*	*TFP_LP*	*TFP_OP*
ESG	0.014***	0.014***		
	(0.005)	(0.004)		
Risk_taking			-14.132**	-14.659**
			(7.035)	(7.018)
Size	0.482***	0.547***	0.502***	0.568***
	(0.020)	(0.019)	(0.027)	(0.026)
ln_staff	0.022	-0.317***	0.014	-0.325***
	(0.015)	(0.015)	(0.019)	(0.019)
Lev	0.180***	0.202***	0.367***	0.395***
	(0.056)	(0.053)	(0.120)	(0.118)
Cashflow	0.607***	0.650***	0.523***	0.563***
	(0.061)	(0.059)	(0.088)	(0.087)
Growth	0.206***	0.200***	0.179***	0.173***
	(0.009)	(0.009)	(0.018)	(0.018)

Dual	-0.005	-0.008	0.008	0.006
	(0.015)	(0.014)	(0.022)	(0.022)
TobinQ	0.013***	0.011**	0.037***	0.036***
	(0.005)	(0.005)	(0.013)	(0.014)
FirmAge	0.122*	0.153**	0.139	0.171*
	(0.063)	(0.060)	(0.099)	(0.099)
Board	0.081*	0.086**	0.055	0.059
	(0.042)	(0.040)	(0.060)	(0.059)
Balance	0.008	0.003	0.069*	0.066*
	(0.016)	(0.015)	(0.037)	(0.037)
Dturn	-0.017***	-0.012**	0.009	0.015
	(0.005)	(0.005)	(0.016)	(0.016)
Mshare	0.067	0.062	-0.187	-0.202
	(0.063)	(0.058)	(0.167)	(0.168)
Constant	-3.315***	-3.936***	-	-
	(0.437)	(0.417)	-	-
Firm	YES	YES	YES	YES
Industry×Year	YES	YES	YES	YES
Observations	18,956	18,956	18,956	18,956
F	154.03	159.64	95.300	92.590

Robust standard errors for clustering to the firm level in parentheses.
*** p<0.01,** p<0.05,* p<0.1.

6. Discussion

Based on the empirical results of this paper, the importance of corporate ESG performance, regional green innovation, regional environmental regulation, and other factors affecting corporate risk-taking in the actual operation of firms are discussed below.

For Hypothesis 1, since firms' actual business activities and investment performance are usually influenced by the firm's management and strategic model choice. Therefore, unlike the existing control mechanisms of risk-taking such as investor protection, management compensation incentives, and shareholder diversity (John et al., 2008; Liu and Mauer, 2011; Faccio et al., 2011), this paper finds that ESG performance is effective in reducing corporate risk-taking (Freeman et al., 2011). This paper focuses on stakeholder theory and finds that corporate ESG performance effectively reduces corporate risk-taking (Freeman, 1984).

While the findings of this paper are opposed to the study of Banerjee and Gupta (2017), a certain degree of country heterogeneity in the original findings was found in the further study of this scholar, especially between developing and developed countries. Meanwhile, the empirical results of this paper are consistent with Di Giuli and Kostovetsky's (2014) and Harjoto and Laksmana's (2018) studies. However, in contrast to He et al. (2023), we do not consider stakeholders' benefits from corporate ESG practices as a direct cost to firm value, which is supported by further tests of firm productivity in this paper. Furthermore, a further study found that corporate ESG performance can achieve corporate total factor productivity gains through the corporate risk-taking path (Harjoto and Laksmana, 2018; Syverson, 2011). This suggests that for corporate ESG practices, incorporating eco-environmental and social responsibility into corporate business strategies can increase corporate value in the long term (Yu et al., 2018). Existing studies also support this finding, confirming the contribution of corporate ESG practices to their performance and sustainability (Baron, 2008; Fatemi et al., 2015; Chin et al., 2022).

For hypothesis 2, corporate green innovation, an important component of ESG practices, can effectively respond to ecological responsibility and social performance (Chin et al., 2022). Therefore, based on stakeholder and resource dependence theories, regional green innovation enhances the inhibitory effect of corporate ESG performance on corporate risk-taking (Frooman, 1999; Backhaus et al., 2002). Compared to the intra-firm green innovation perspective of Kraus et al. (2020) and Chin et al. (2022), this paper effectively confirms the role of external resources in influencing firms' ESG practices. The empirical results remain consistent with existing studies (Huang and Li, 2015; Zhang, 2022).

For hypothesis 3, strict environmental regulations exacerbate firms' risk concerns (Xue et al., 2020). Therefore, based on stakeholder and institution-based view theories, this paper finds that regional environmental regulation enhances the inhibitory effect of corporate ESG performance on corporate risk-taking (Dacin et al., 2007; Peng et al., 2008; Wernerfelt, 1984). The empirical results are consistent with the study of Xue et al. (2020). Furthermore, although Banerjee and Gupta (2017) argue that environmental

constraints make environmentally friendly firms increase their investments in risky projects, regional environmental regulation can enhance firms' drivers of environmental benefits and achieve technological compensation to some extent (Song et al., 2022). Therefore, there may be sample differences in the moderating effect of regional environmental regulation.

The regression analysis results also indicate a negative relationship between firm growth and firm risk-taking (Faccio et al., 2016). It suggests that when firms operate with smooth growth, they do not need to make excessive investment expenditures, and risk-taking is relatively low. It aligns with the current research findings (Habib and Hasan, 2017). Regarding corporate governance, executive shareholding does not promote corporate risk-taking (Hayes et al., 2012). The potential reason could be that when executive equity incentives increase, corporate decisions are instead more conservative (DeFusco et al., 1991). In addition, equity checks and balances can enhance corporate risk-taking and create an internal drive to choose high-risk, high-return projects (Koerniadi et al., 2014). Corporate leverage is positively related to risk-taking, consistent with existing studies (Bird et al., 2018; Koirala et al., 2020). Regarding capital market performance, Tobin's Q and the average monthly excess turnover rate significantly correlate with corporate risk-taking. It suggests that firms take more risky decisions when their investment demand and investor sentiment are stronger (Arif and Lee, 2014; Habib and Hasan, 2017).

7. Conclusion and implications

To better understand the fundamental role of ESG practices in an ecosystem-oriented business model, this paper develops a high-dimensional fixed-effects multiple linear regression model to capture the effect of corporate ESG performance on corporate risk-taking. Empirical results from a sample of 20,238 listed companies in China from 2009 to 2020 largely support the hypotheses of this paper. The results show that corporate ESG performance significantly reduces corporate risk-taking. This effect is enhanced by the high level of green innovation and environmental regulation in the city where the firm is located. That is, the greater the influence of regional

environmental regulation and regional green innovation, the stronger the effect of corporate ESG performance on corporate risk-taking. Further study finds that corporate ESG performance can effectively enhance total factor productivity through corporate risk-taking as a mediator. All of the above findings support the underlying logic of the research questions in this paper.

The results of this paper provide empirical evidence that firms reduce risk-taking and increase firm productivity. High levels of risk-taking are not conducive to productivity improvement, and ESG performance can effectively help companies reduce risk-taking. Therefore, in the long run, companies that want to achieve future corporate value enhancement and sustainability may need to integrate environmental and social responsibility into their strategic models and thus transform their current linear business models. The findings of this paper offer suggestions for policymakers to help companies improve their ESG performance. First, regional green innovation can enhance the impact effect of corporate ESG performance on risk-taking. Local governments should strengthen infrastructure development and introduce technical talents to enhance the ESG performance of enterprises in ecosystem-oriented business models through the spillover effect of green innovation. Second, local governments should pay attention to strengthening the attention to the green ecological environment of the region. Considering the goal-oriented situation of sustainable corporate development, local governments should appropriately complement this weak link and may consider adopting market-incentivised environmental regulations to strengthen corporate ESG practices.

This study has several limitations, which provide directions for future research. First, although the findings of this paper provide empirical evidence on emerging economies, China, as the largest developing country, is somewhat unique among many emerging countries in terms of its status as an emerging economy, large market size, and political system. That is, the results of our analysis may differ in other emerging country samples due to differences in their characteristics. Therefore, in future studies, we may extend to other Asian country samples of firms, especially other emerging economies. Second, due to data availability, our study is mainly based on a sample of

Chinese-listed firms. Therefore, the above findings may not apply to MSMEs more sensitive to external resources and institutions. Finally, we call for more studies to replicate the findings of this paper and to consolidate the findings.

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