Does biodiversity risk affect corporate green innovation? — Evidence from China

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1. Introduction

Currently, the speed and extent of biodiversity degradation in many countries, including China, have reached unprecedented levels (Karolyi and Tobin-de la Puente, 2023). The loss of ecosystem-related services amounts to approximately 15 trillion US dollars annually, exerting a significant impact on the economy and society (Kapnick, 2022). To confront the challenges posed by biodiversity loss, countries and international organizations have united their efforts, and to date, 196 contracting parties have signed the Convention on Biological Diversity, jointly exploring pathways to achieve global ecosystem health and sustainable development goals for human society. Against this backdrop, China, as a responsible major country, has played an important leading role in global biodiversity conservation. It has actively implemented and fulfilled the Convention on Biological Diversity, formulated the "China's Biodiversity Conservation Strategy and Action Plan (2023–2030)," and is committed to promoting the realization of domestic and international biodiversity conservation goals. However, compared with developed countries, China faces a dual task: it must not only rectify the deficiencies in the realm of green technology and products but also sustain rapid economic growth (Lei et al., 2025; Zhang et al., 2025; Li et al., 2024). This dual challenge stems from China's current position at a pivotal juncture of high-quality economic development, where sustainable development needs to be achieved under the constraints of resources and environmental pressures. To this end, China needs to prioritize green innovation as the key impetus for achieving high-quality economic development to effectively address ecological and environmental challenges (Chen et al., 2024). The realization of biodiversity goals requires the joint efforts of multiple parties, with enterprises being an important entity among them (Díaz et al., 2019). On December 10, 2024, the Shan Shui Conservation Center and other institutions jointly released the "Corporate Biodiversity Pressure Assessment Report (2021)," with the hope of assisting enterprises in achieving green development transformation, exploring a virtuous interaction between green ecology and economic development, and showcasing the results of cross-boundary exploration in biodiversity mainstreaming. Therefore, researching how Chinese enterprises can enhance their biodiversity awareness and capacity to address biodiversity risks, and promote green transformation, can provide references for developing countries to achieve high-quality economic development.

Recent studies indicate that biodiversity risk can exert diverse negative effects on businesses. Li et al. (2025) pointed out that biodiversity risk can reduce corporate efficiency by increasing external financing needs and costs. Gbenga (2024) argues that corporate biodiversity risk and climate vulnerability may lead to the outcome of corporate bankruptcy. Moreover, the physical and transition risks relevant to biodiversity issues have the potential to heighten the fluctuation of corporate profitability and cash flow, which may trigger market concerns and elevate the risk of future stock market crashes (Ma et al., 2024; Liang et al., 2024; Giglio et al., 2023). Nevertheless, the prevailing research predominantly centers on how biodiversity risks affect the routine business activities of companies. In fact, the external pressures driven by the demand for sustainable development force companies to pay attention to green innovation.

The loss of biodiversity can bring risks to businesses, such as interruptions in raw material supply, deterioration of the production environment, damage to market reputation, and increased regulatory pressure. To counteract the negative impacts of biodiversity risks, companies often choose to improve the production environment and restore corporate reputation and alleviate external regulatory pressure by strengthening green innovation efforts. However, from another perspective, the greater the biodiversity risk, the more likely companies may choose to hold sufficient cash as emergency funds for biodiversity risks, thereby crowding out investment in high-risk innovative activities. Thus, how does biodiversity risk relate to corporate green innovation? Does this relationship exhibit heterogeneity depending on corporate characteristics? And what are the mechanisms of its impact? Clarifying these issues can not only offer new perspectives on how companies can manage and respond to biodiversity risks, but also furnish valuable guidance for policymakers on how to encourage corporate green innovation.

Drawing on the existing literature, we examine the relationship and underlying mechanisms between the biodiversity risks confronting enterprises and their green innovation initiatives. We employ panel data from Chinese A-share listed companies from 2009 to 2022 to empirically investigate the impacts and mechanisms through which biodiversity risks influence corporate green innovation, and examine the moderating roles of government green subsidies, CEO green experience, and technological diversification. The research reveals that the higher the biodiversity risks enterprises face, the more inclined they are to advance green innovation. This impact is especially pronounced among non-SOEs, those with low financial constraints, highly competitive companies, and high-tech enterprises. Furthermore, the mechanism analysis suggests that enterprises confronting greater biodiversity risks tend to draw the scrutiny of external analysts and alleviate managerial myopia, which incentivize them to pursue green innovation. Additionally, government green subsidies and the green experience of CEOs within the company have a significant positive moderating effect, while technological diversification exhibits a clear negative moderating effect.

Our study may offer the following four incremental contributions: First, we pioneer to examine the impact of biodiversity risks on corporate green innovation strategies, thereby enriching green innovation influencing factors by incorporating the dimension of biodiversity risk. Existing research centers on the adverse consequences for corporates' operation resulting from biodiversity risk, with less attention given to how enterprises can respond to biodiversity risk. By examining how biodiversity risk affects corporate green innovation, we offer fresh perspectives on how enterprises can respond when facing ecological challenges. Second, we further refine the dimensions of corporate green innovation. This method more intuitively highlighting the promoting role of biodiversity risk on substantive and strategic green innovation. It reveals which type of green innovation is preferred by enterprises when facing biodiversity risk, which is of significant importance for enterprises to accurately choose green innovation strategies. Third, when facing high environmental uncertainty, enterprises commonly take green innovation actions to improve their responsible image. We reveal the mechanism by which corporate biodiversity risk affects green innovation through the lenses of external regulation and internal managerial myopia. Fourth, we emphasize the varying impacts of biodiversity risk on corporate green innovation across different scenarios, offering theoretical grounding to guide enterprises in strengthening their green innovation capabilities and encouraging their involvement in the green transformation process. We find that it is essential to effectively make full use of the government's role in external incentives and guidance, focus on supporting non-SOEs, high-competition, high-tech enterprises, and actively introduce managers with green experience, thereby encouraging enterprises to continuously improve their green innovation levels and actively respond to biodiversity risk.

The framework for subsequent arrangement is as follows: Section 2 presents theoretical analyses and develops research hypotheses; Section 3 elaborates the variable selection, model specification, and data sources; Section 4 offers a detailed explanation of the empirical results and conducts robustness analysis; Section 5 examines the pathways by which biodiversity risk impacts green innovation and explores the associated moderating factors. We conclude with research findings and policy recommendations.

2. Hypothesis development

2.1. Biodiversity risk and corporate green innovation

Current studies have shown that climate risks can profoundly influence corporate operations and investment decisions (Ren et al., 2024). Since climate risks negatively affect various aspects of a company, including its core business, value chain, infrastructure for production and operational activities, and supply chain (Pankratz and Schiller, 2024; Somanathan et al., 2021), companies are compelled to adjust their business strategies. They do this by increasing green innovation as a means to tackle these risks (Tian et al., 2024; Dutta et al., 2023; Linnenluecke et al., 2013).

Biodiversity loss, as a main outcome of climate changes (Mantyka-Pringle et al., 2015), also affects the operations of businesses (Bassen et al., 2024; White et al., 2023; Smith et al., 2020; Kedward et al., 2023). Therefore, businesses can harness green innovation to strategically counteract biodiversity risks as same as climate risks (Pi et al., 2025). On the one hand, biodiversity risks may pose considerable implications for the supply chains of businesses. According to the Conservation of Resources (COR) theory, there is a common tendency among individuals to retain, defend, and gather resources, and they will choose to increase investment to avoid or reduce corresponding losses when there is a threat of potential or actual resource loss (Hart, 1995). Therefore, given the potential losses that biodiversity risks may cause, businesses may preemptively invest in green innovation, which can not only reduce dependence on limited natural resources but also effectively lower the adverse impact of these risks on their business value. Moreover, it can even help businesses gain a competitive advantage (Qi et al., 2025; Ito and Brotheridge, 2003). On the other hand, green innovation can enhance a company's reputation while helping it gain the support of stakeholders (Bannier et al., 2022). According to stakeholder theory, stakeholders including the government, investors, customers, employees, shareholders, and industry associations have a significant impact on a company's operational decisions and green performance (Kabir et al., 2021; Zhang et al., 2017). Companies should carefully consider the expectations and needs of their stakeholders, and while pursuing economic benefits, they should also attach importance to social responsibility and environmental protection to ensure long-term sustainable development (Freeman and Phillips, 2002; Gao et al., 2025). Albino et al. (2012) believe that government intervention directly promotes green innovation, and customers, non-governmental organizations, other companies, and so on, also impact green innovation; Cai and Zhou (2014), Doran and Ryan (2016) found that when competitors advance green innovation, it drives other companies to innovate greenly; additionally, Tang and Tang (2016), Shen and Feng (2012), and Wang et al. (2017) have found that public opinion pressure is also a driving force for corporate green innovation.

As environmental protection measures become increasingly stringent and public awareness of biodiversity conservation intensifies, companies' biodiversity issues are increasingly coming under stakeholder scrutiny. Companies facing biodiversity risks often experience heightened stakeholder pressure, as investors, consumers, and advocacy groups demand more sustainable practices. To preserve their reputation and secure stakeholder support, they are driven to engage in green innovation and undergo a green transformation. This allows them to better address the transformation risks brought about by regulatory changes directly caused by biodiversity risks and explore new paths for protecting biodiversity. Consequently, the decision for companies to pursue green innovation is a long-term sustainable strategic choice made after comprehensively considering pressures from the government and the public, as well as their own interests and development.

Hence, we formulate the following hypothesis:

H1: Higher biodiversity risk drives more green innovation in companies.

2.2. Biodiversity risk and substantive, strategic green innovation

While implementing green innovation, companies may exhibit differentiated behavioral outcomes due to distinct motivations for innovation, manifesting as "high-level, high-difficulty" substantive innovation behaviors and "quantity-focused, quality-neglected" strategic innovation behaviors. Drawing from Li and Zheng (2016), we further refine green innovation into substantive green innovation and strategic green innovation. Generally, substantive green innovation places greater emphasis on the quality of innovation, with higher difficulty and risk, and can produce significant economic and environmental benefits upon success. Conversely, strategic green innovation denotes innovation that is purpose-driven, such as focusing on achieving financial gains or meeting minimum regulatory standards, rather than striving for long-term environmental sustainability (Duque et al., 2020).

From one perspective, according to institutional theory, organizations will gain social recognition, resources, and legitimacy by meeting the expectations of institutional environment, thereby fulfilling the requirements of sustainable development and achieve long - term growth of corporate performance (Ahmed et al., 2020; Konwar et al., 2024; Scott, 2005). Therefore, when enterprises are facing huge environmental institutional pressures, it may force enterprises to take green innovation actions (Adomako and Nguyen, 2023; Shu et al., 2016; Wen et al., 2023). At this time, enterprises may view strategic green innovation as a compliance strategy, which allows for the minimum adjustment of core business while complying with policy requirements. This approach avoids making heavy investments in transformative green innovation. In contrast, substantive green innovation requires significant modifications to business processes and products, thus bringing higher risks (Cai et al., 2020). Therefore, when facing biodiversity risks, enterprises may give priority to catering to external strategic innovation, minimizing risks while meeting policy requirements, rather than pursuing truly impactful green innovation.

From another perspective, in accordance with the resource dependence theory, organizational development is intrinsically linked to the acquisition of external resources, and organizations will take strategic actions to reduce these dependencies (Wang et al., 2024; Pfeffer and Salancik, 2015). The loss of biodiversity poses significant challenges to enterprises, such as interruptions in raw material supply, resource scarcity, and deterioration of the production environment, directly threatening the company's ability to obtain key resources and potentially harming its competitiveness, prosperity, and sustainability (Haque and Jones, 2020). In this situation, what drives corporate behavior is not the biodiversity risk itself, but the impact of costs and business opportunities. To minimize losses, companies have a direct incentive to ensure the quality and quantity of ecosystem services they depend on by maintaining the functionality of ecosystems (Bishop, 2013). This requires substantial green innovation to truly reduce dependence on limited resources, enabling the company to thrive in a resource-constrained environment and minimize the adverse consequences of biodiversity physical risks for business operations.

Given the above considerations, we introduce the following research hypotheses:

H2a: Biodiversity risk affects various types of corporate green innovation differently, with a more pronounced positive impact on strategic green innovation.

H2b: Biodiversity risk affects various types of corporate green innovation differently, with a more pronounced positive impact on substantive green innovation.

2.3. The external supervisory mechanism analysis: analyst attention

It has been indicated by some studies that investors in the market pay attention to a company's biodiversity (Garel et al., 2024; Han and Li, 2022). Analysts, as external regulators, quickly respond to a company's biodiversity performance, helping various stakeholders understand the company's situation and make decisions. Furthermore, acting as "megaphones" or "amplifiers," analysts bridge the gap between companies and investors through their professional interpretation of information and continuous monitoring, effectively promoting positive market perceptions of companies (Liu and Chen, 2018) and amplifying external attention to corporate biodiversity risks. According to incentive mechanism theory, investor attention can catalyze corporate green innovation via incentive mechanisms. Market investors are instrumental in shaping a company's green innovation strategy (Zhang et al., 2024; Tang et al., 2024). Their emphasis on and anticipation of biodiversity can amplify a company's reputational risk and social pressure. In order to align with investor expectations and demands, companies may be more inclined to pursue green innovation. Therefore, when facing biodiversity risks, analyst attention can serve as external oversight, encouraging companies to allocate resources to green innovation with a long-term orientation, effectively mitigating the challenges posed by biodiversity risks.

As a result, we hypothesize as follows:

H3a: The rise in biodiversity risk will lead enterprises to undertake green innovation via the external supervisory mechanism of heightened analyst attention.

2.4. The internal management mechanism analysis: managerial myopia

In corporate management, managerial myopia refers to the phenomenon where managers, in the process of making operational and investment decisions, overly focus on short-term performance due to considerations of personal interests or career development, while neglecting the long-term interests of the enterprise (Stein, 1988;

Cao et al., 2023; Zhang et al., 2023). The root of managerial myopia lies in the multiple pressures that managers face from capital markets, shareholders, and career advancement. These pressures drive them to prioritize the improvement of short-term financial metrics in order to meet market expectations and safeguard their own career interests. Green innovation, as a strategic initiative characterized by long-term benefits and uncertainty, typically requires sustained resource allocation from firms and is unlikely to generate significant economic returns in the short term. These characteristics make green innovation particularly vulnerable to suppression by managers with short-sighted behavior. Specifically, myopic managers tend to pursue short-term returns to meet immediate profit expectations, thereby reducing investment in long-term projects such as green innovation (Yu et al., 2024; Zhang and Li, 2024; Li et al., 2021).

Biodiversity risk, as an emerging and complex external constraint, is increasingly drawing widespread attention. This risk encompasses not only the potential impact of corporate operations on the ecological environment but also has close ties to a company's long-term strategy and reputation management. When companies face high levels of biodiversity risk, they tend to attract significant attention from external stakeholders, including investors, environmental organizations, regulatory bodies, and the general public (Liu et al., 2024; Liao and Xiao, 2025; Wang and Cao, 2024). The intensification of external oversight serves two primary functions. First, it enhances the transparency of managerial decision-making, reduces information asymmetry, and encourages managers to more carefully weigh short-term gains against long-term objectives when formulating policies. Second, through feedback and pressure from stakeholders, it prompts companies to allocate more resources towards biodiversity conservation, green innovation, and sustainable development (Sun et al., 2024; Barth et al., 2001). This external constraint not only helps to mitigate managerial myopia but also drives companies to undergo strategic transformation in the process of addressing biodiversity risks.

Thus, we propose hypothesis H3b:

H3b: The rise in biodiversity risk will lead enterprises to undertake green innovation via the internal management mechanism of lessened managerial myopia.

2.5. The moderating effects analysis: CEO green experience, government green subsidy and technological diversification

Upper echelons theory posits that executives are key determinants of organizational strategic choices and performance outcomes. They make decisions within the bounds of rationality, influenced by their strategic environment and individual psychological characteristics, which ultimately affect corporate behavioral decision - making choices and performance (Hambrick and Mason, 1984). Existing research has shown that CEOs' green experience is conducive to corporate green innovation (Huang and Wei, 2023; Lu and Jiang, 2022), and CEOs' perception of the environment determines how enterprises take environmental response actions (Xu et al., 2017). CEOs with green experience may promote corporate green innovation out of social responsibility and moral constraints to mitigate the negative environmental impacts of corporate activities; they may also do so out of profit - seeking motives, regarding green innovation as an important source of profit to reduce costs and increase revenue (Gadenne et al., 2009). Regardless of the motive, CEOs with green experience tend to prioritize sustainability issues more highly and devote more resources to addressing them. Therefore, when facing biodiversity risks and the interests and expectations of stakeholders in ecological protection, CEOs with green experience will be more motivated and capable of responding to them, implementing green innovation in a timely manner, internalizing these external pressures, and gaining the recognition of stakeholders.

Considering the resource-based view, government green subsidies can provide additional resources to fuel corporate green innovation, lower the research and development costs, and ease the financial constraints that green innovation often encounters (Liu et al., 2019; Zhang and Zhao, 2022). In addition, the signaling effect of government green subsidies can convey positive signals to stakeholders, providing an opportunity window for the inflow of external resources for enterprises (Yang et al., 2015), such as the introduction of high-tech talents, inter-organizational technical knowledge exchange (Liu et al., 2024), and the construction of principal trust mechanisms (Yang et al., 2021). Therefore, whether for getting resources or sending signals, in the face of biodiversity risks, government green subsidies can supply additional resources and financial backing for corporate green innovation, thereby fostering a more supportive environment for green innovation. For this reason, enterprises will ramp up their investment in green innovation activities, thereby promoting the improvement of green innovation performance.

Technological diversification might hinder corporate green innovation. Technological diversification means that enterprises need to invest in multiple technological fields, which will lead to the dispersion of limited innovation resources and innovative energy. Green innovation often requires substantial capital, human resources and time investment. When a company's resources are allocated to other technological areas, the resources used for green innovation will be reduced, reducing the enterprise's attention to and investment in green innovation (Shin and Jalajas, 2010). In addition, Granstrand (1998) proposed that a diversified technological portfolio may bring more integration, coordination and communication costs to enterprises, and excessive technological diversification may destroy the consistency of the organization (Granstrand and Oskarsson, 1994), resulting in the enterprise losing control over its capability leverage and combinational capabilities. All of the above impacts will hinder the enterprise's green innovation activities. Therefore, enterprises with a wider range of technological diversification may be less likely to prioritize green innovation behaviors aimed at reducing biodiversity risks.

Therefore, we set forth the following research hypotheses:

H4: The impact of biodiversity risk on promoting corporate green innovation will be amplified by CEO green experience and government green subsidies.

H5: The impact of biodiversity risk on promoting corporate green innovation will be weaken by technology diversification.

The detailed mechanism analysis framework diagram illustrated as Figure 1.

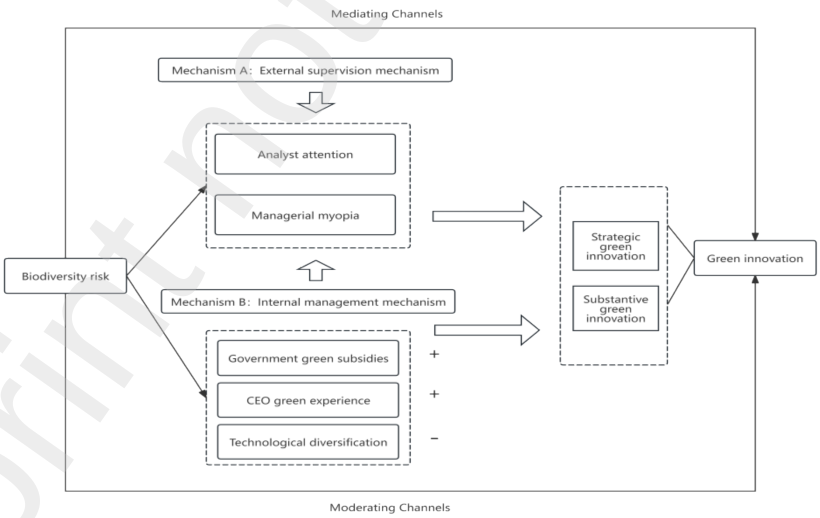

Figure 1. Framework diagram of the mechanism between biodiversity risk and green innovation.

3. Methodology

3.1. Samples and data

We use data from Chinese A-share listed companies (2009–2022) to empirically examine the impact of biodiversity risk on corporate green innovation empirically. We drew the firm-level data from the Wind database, CSMAR database, and annual reports.

To make the results reliable, we subjected the sample to the following procedures: (1) omitting samples classified as ST and PT; (2) excluding the financial and insurance firms; (3) discarding samples that have substantial missing variable values; (4) all variables have been winsorized at the 1% level. We ultimately obtained 36,085 valid observations.

3.2. Variable specification

3.2.1. Dependent variable

Corporate green innovation encompasses both green innovation input and output, but disentangling green innovation input from total R&D expenditure is a complex task. Therefore, we consider the number of green patent applications as a surrogate for green innovation (Wang and Wang, 2021; Wang et al.,2023). The reasons are outlined below: (1) it better reflects the company's willingness and output level in green innovation; (2) The process from patent application to authorization is lengthy, making it a more timely and more accurate indicator compared to other metrics.

We sum the number of green invention patents and green utility model patents to obtain the total amount of green innovation ($GIno$), and then define these two types of patents as substantive green innovation ($GIno\_Subst$) and strategic green innovation ($GIno\_Strat$), respectively. Since some companies may have no green patent applications and patent data is discrete, we refer to Li and Zheng (2023) and apply a log transformation after adding one.

3.2.2. Core explanatory variable

We employ text analysis to assess the biodiversity risks faced by enterprises (He et al., 2024). Firstly, we utilize the biodiversity keyword list (Giglio et al., 2023), which encompasses biodiversity-related terms such as biodiversity, ecosystem, ecology, biosphere, etc. Subsequently, we analyze the annual reports of Chinese listed companies to gauge the frequency of biodiversity-related terms. Lastly, the frequency of the terms is taken as the biodiversity risk index (BR): if the term frequency exceeds two times, the value is set to 1, otherwise it is 0. It should be noted that we also calculate the biodiversity risk index ($BR2$) as a robustness test indicator, which is the proportion of biodiversity-related terms in the annual report compared to the total number of characters.

3.2.3. Mechanism variable

(1) Analyst attention ($AnaAttention$)

It usually refers to the research and tracking of enterprises, industries, or markets by securities analysts, as well as their degree of concern about the future performance and development prospects of enterprises. As in Chen et al. (2017), we limit the selection period of analyst attention data to the time from the release of the enterprise's annual report in year t to t+1. On this basis, the count of analysts tracking the listed company is selected, and after logarithmic processing, it serves as the measurement metric for analyst attention ($AnaAttention$).

(2) Managerial myopia ($Myopia$)

Following Hu et al. (2021), the data were extracted from the Management Discussion and Analysis (MD&A) section of financial reports through textual analysis. First, expressions related to "short-termism" in the MD&A were analyzed, including terms like within days, in a few months, and opportunity. Subsequently, the Continuous Bag of Words (CBOW) model in Word2Vec was employed to train the corpus of annual financial reports. A final lexicon of 43 "short-termism"-related words was established. Based on the dictionary method, the managerial short-termism index ($Myopia$) was calculated using Equation (1). The larger this value is, the more myopia the managers are.

$$Myopia = \frac{Total\_Myopia}{Total\_MD\&A} \times 100 \qquad (1)$$

In Equation (1), $Total\_Myopia$ is the total frequency of short-termism-related words; $Total\_MD\&A$ is the total word count in the MD&A.

3.3.4. Moderating Variable

(1) CEO green experience ($Green$)

Following from existing research (Jiang and Huang, 2013; Xu and Li, 2016), we examine the personal resume data of executives to determine if the CEO's background features "green"-related education or employment. If the personal resume information includes key terms like environment, ecology, clean energy, low-carbon, sustainability, etc., we deem that the CEO possess green experience, and Green is marked as 1. Otherwise, the value is 0.

(2) Government green subsidies (GS)

Government green subsidies are chiefly assessed based on the volume of green subsidies received by enterprises from relevant government authorities. In the specific calculation process, we draw on the approach of Li and Xiao (2020) and Yu (2021). We search for the government subsidy programs received by enterprises in their annual reports to screen out green subsidy projects. Then, we sum the subsidy amounts to get the total green subsidies. If a government subsidy project's name contains terms like green, clean, environment, or sustainable development, etc., it is considered that the enterprise has received a certain green subsidy. We measure government green subsidies (GS) using the scale-adjusted relative level of environmental subsidies.

(3) Technology diversification (TD)

Technological diversification reflects the breadth of distribution of a company's patents across various technological fields. Currently, in the measurement of technological diversification, scholars typically employ the Herfindahl-Hirschman Index (HHI) method and the entropy index method. Following the approach of Garcia-Vega (2006), suppose that N_i represents the count of patents in technology field i held by the enterprise, $N = \sum_i N_i$. The equation for determining technological diversification is:

$$TD = 1/(\sum_i (N_i / N)^2) \quad (2)$$

If a company's technological scope is relatively narrow, the value of $\sum_i (N_i / N)^2$ is relatively higher, indicating a lower degree of technological diversification. Conversely, it is higher.

3.2.5. Control variables

Consulting the existing literature on green innovation (Xie and Zhu, 2021; Liu and Xiao, 2022; Ling and Gao, 2023; Tian et al., 2024), the following control variables are selected at the company level: asset-liability ratio (Lev), return on assets

(ROA), firm size ($Size$), cash flow level ($Cashflow$), growth potential ($Grow$), and Tobin's Q ($TobinQ$). Additionally, corporate governance level also affects green innovation, so board independence ($Indep$) (Luo and Tang, 2021) and dual leadership of the board ($Dual$) (Amore and Bennedsen, 2016) are included as control variables.

Table 1

Variable definitions.

Type	Name	Symbol	Definition
Dependent variable	Green innovation	$GIno$	Ln (green patent applications +1)
	Strategic green innovation	$GIno\_Strat$	Ln (green invention patent +1）
	Substantial green innovation	$GIno\_Subst$	Ln (green utility model patent +1)
Core Explanatory Variable	Biodiversity risk	BR	If the frequency is greater than 2, the value is 1; otherwise, 0.
Mechanism Variable	Analyst attention	$AnaAttention$	The log of analysts covering the listed company.
	Managerial myopia	$Myopia$	$Myopia = \frac{Total\_Myopia}{Total\_MD\&A} \times 100$
Moderating Variable	Government green subsidies	GS	Annual subsidies related to environmental protection received.
	CEO Green Experience	$Green$	(government green subsidies / total assets) * 100
Control Variable	Technological Diversification	TD	$TD = 1/(\sum_i (N_i / N)^2)$
	Financial leverage	Lev	The debt-to-asset ratio.
	Profitability	ROA	The net profit margin on assets.
	Firm size	$Size$	Ln (company's total assets)
	Cash flow level	$Cashflow$	Net cash flow to assets ratio.
	Growth	$Grow$	Year-over-year growth rate of operating revenue.
	Tobin Q value	$TobinQ$	Market-to-replacement ratio.
	CEO duality	$Dual$	A dummy variable equals 1 if the chairman is also CEO and 0 otherwise.

Board independence	*I*ndep	The ratio of independent to total directors.

3.3. Descriptive statistics

Table 2 shows the descriptive statistics of key variables. The findings reveal that corporate green innovation has an average of 0.320, a median of 0, and a standard deviation of 0.555. These statistics indicate a relatively modest degree of green innovation among China's listed companies, with a notable disparity in green innovation levels across different firms, reflecting uneven innovation capabilities. Particularly, the average substantive green innovation stands at 0.213, whereas strategic green innovation averages 0.184. This suggests that China's overall level of substantive green innovation exceeds that of strategic green innovation, yet both remain relatively low. Furthermore, the average biodiversity risk among companies is 0.447 (SD=0.497), indicating that nearly half of enterprises are facing biodiversity risks, and there are significant differences in the biodiversity risks faced by companies of different industry types.

Table 2

Descriptive statistics.

Variables	N	Mean	Std. Dev.	Min	P50	Max
GIno	36085	0.320	0.715	0.000	0.000	3.258
GIno_Strat	36085	0.184	0.495	0.000	0.000	2.398
GIno_Subst	36085	0.213	0.558	0.000	0.000	2.773
BR	36085	0.447	0.497	0.000	0.000	1.000
Size	36085	22.195	1.305	19.415	22.005	26.430
Lev	36085	0.423	0.205	0.027	0.415	0.925
ROA	36085	0.043	0.065	-0.375	0.041	0.254
Cashflow	36085	0.048	0.069	-0.224	0.047	0.283
Growth	36085	0.166	0.390	-0.653	0.108	3.808
TobinQ	36085	2.065	1.375	0.802	1.640	16.647
Indep	36085	37.520	5.366	25.000	35.710	60.000
Dual	36085	0.275	0.446	0.000	0.000	1.000

3.4. Model construction

We establish an empirical model (3) to analyze how biodiversity risks affect GIno:

$$GIno_{i,t} = \alpha_0 + \alpha_1 BR_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (3)$$

Where, the dependent variables $GIno_{i,t}$ is the indexes of corporate green innovation at the firm level i in year t; the explanatory variable $BR_{i,t}$ is the biodiversity risk for a firm; $Control_{i,t}$ symbolizes control variables; $inddum$ represents industry fixed effect, $yeardum$ denotes annual fixed effects, and $\varepsilon_{i,t}$ is the random error term.

To investigate the channels through which biodiversity risks affect corporate green innovation, we employ analyst attention and managerial myopia as mechanism variables. The specific model setup is as follows:

$$M_{i,t} = \beta_0 + \beta_1 BR_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (4)$$

$$GIno_{i,t} = \beta_0 + \beta_2 M_{i,t} + \beta_3 BR_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (5)$$

Among them, $M_{i,t}$ represents the mechanism variables. If β_1 and β_2 are significantly positive, it can show that biodiversity risks can promote corporate green enterprise innovation by increasing analysts' attention. H3a was proven. Besides, if β_2 is significantly negative, H3b can be proven.

Model (6)-(8) is designed to test the moderating effects of CEO green experience, government green subsidy and technology diversification, respectively:

$$GIno_{i,t} = \alpha + \beta BR_{i,t} + \delta_1 BR_{i,t} \times Green_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (6)$$

$$GIno_{i,t} = \alpha + \beta BR_{i,t} + \delta_2 BR_{i,t} \times GS_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (7)$$

$$GIno_{i,t} = \alpha + \beta BR_{i,t} + \delta_3 BR_{i,t} \times TD_{i,t} + \sum \gamma_k Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (8)$$

If the coefficient δ_1, δ_2 is positive, we can know that government green subsidies and the CEO's green experience enhance the positive effect. H4 is verified. Besides, if the coefficient δ_3 is negative, it indicates a negative moderating effect of technological diversification, thus validating H5.

4. Empirical results and discussion

4.1. Benchmark results

We display the baseline outcomes in Table 3. Across all the columns of Table 3, biodiversity risks can drive corporate green innovation. After including year and industry fixed effects or simultaneously including a series of control variables and fixed effects, the empirical results keep significantly positive. Moreover, a one standard deviation increase in biodiversity risks boosts corporate green innovation by 6.2% (=0.497×0.040/0.320) relative to the mean. This suggests that the biodiversity risks faced by enterprises positively drive their green innovation, thus verifying H1a. The reason for this, we believe, is that Chinese enterprises depend on biodiversity at multiple levels, from direct resource utilization to indirect ecosystem services, as well as compliance risks and economic impacts. Only through tangible green innovation results can enterprises truly mitigate the losses caused by biodiversity risks. Otherwise, enterprises will face significant economic costs due to the interruption of raw material supply, resource scarcity, and the deterioration of the production environment caused by biodiversity loss. Therefore, when facing biodiversity risks, enterprises have an inherent incentive and motivation to strive green innovation.

Concerning the control variables, firm size, cash flow, and return on assets positively affect corporate green innovation, matching the hypothesis that larger firms, with more ample funds and stronger profitability, have a greater capacity to attain greater innovation levels. In contrast, the revenue growth rate negatively affects the degree of $GIno$. This may be because as a company's revenue grows rapidly, the good operating status leads to complacency among management, reducing their enthusiasm for green innovation, thereby suppressing the company's green innovation efforts.

Furthermore, to explore in depth which type of green innovation behavior is more affected by biodiversity risks, following the existing practice of categorizing green innovations, we also conduct regression analyses for strategic green innovation ($GIno\_Strat$) and substantive green innovation ($GIno\_Subst$) separately. Compared to the overall level of green innovation shown in column (3), BR coefficients in columns (4) and (5) have slightly decreased (from 0.040 to 0.009 and 0.034, respectively), and only in column (5) is significant, indicating that biodiversity risks have a significant promoting effect only on $GIno\_Subst$ but not $GIno\_Strat$. The impact of biodiversity risks on corporate green innovation is chiefly seen in substantive green innovation. The reason might be that substantive green innovation with its higher technical content, is better equipped to address the adverse effects of biodiversity physical risks on business operations, thereby conferring a competitive advantage. In addition, according to the profit maximization decision-making objective (Hering and Poncet, 2014), if the cost savings and benefits derived from substantive green innovation in addressing biodiversity risks outweigh the associated innovation costs, enterprises may opt to develop invention patents to maximize corporate earnings over the long run. Thus, companies confronting biodiversity risks may determine that engaging in higher-quality, substantive green innovation activities is more optimal, thereby verifying H2b.

Table 3

Baseline regression.

	(1)	(2)	(3)	（4）	（5）
Variables	GIno	GIno	GIno	GIno_Strat	GIno_Subst
BR	0.117***	0.110***	0.040***	0.009	0.034***
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)
Size			0.125***	0.067***	0.106***
			(0.005)	(0.003)	(0.004)
Lev			0.150***	0.097***	0.089***
			(0.022)	(0.015)	(0.017)
ROA			0.523***	0.294***	0.344***
			(0.061)	(0.043)	(0.048)
Cashflow			0.042***	0.014***	0.028***
			(0.053)	(0.037)	(0.042)
Growth			-0.050***	-0.023***	-0.041***
			(0.008)	(0.006)	(0.006)
TobinQ			0.010***	0.002	0.014***
			(0.003)	(0.002)	(0.002)
Dual			0.023**	0.014**	0.022***
			(0.008)	(0.006)	(0.007)
Indep			-0.001	-0.001	-0.000
			(0.001)	(0.000)	(0.001)
_cons	0.268***	0.273***	-2.543***	-1.353***	-2.230***
	(0.005)	(0.005)	(0.106)	(0.074)	(0.087)
Controls	No	No	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Ind FE	No	Yes	Yes	Yes	Yes
N	35529	35529	35529	35529	35529
R^2	0.007	0.137	0.180	0.152	0.159

Notes： * p < 0.10, ** p < 0.05, *** p < 0.01, and t statistics in parentheses. The same as below.

4.2. Robustness checks

4.2.1. Alternative measures of variables

We adopt alternative methods to assess corporate green innovation and biodiversity risks and re-examine them using regression model (1).

(1) Corporate green innovation

First, we calculate the proportion of green patent applications to total patent applications for the year ($GIno\_Ratio$); second, we use ln (1+ the count of green patents acquired) ($GIno\_Grants$). The BR regression coefficients in Table 4, columns (1) and (2), are significantly positive, implying that biodiversity risk still significantly positively impacts on $GIno$, thereby affirming H1.

(2) Biodiversity risks

We choose the proportion of biodiversity-related characters to the total characters ($BR2$) as an alternative variable for biodiversity risk. The regression coefficient for $BR2$ in column (3) of Table 4 is significantly positive which matches the benchmark outcomes. Therefore, the findings exhibit robust.

Table 4

Replacement of core variables.

Variables	(1) GIno_Ratio	(2) GIno_Grants	(3) GIon
BR	0.007***	0.020***	
	(0.001)	(0.005)	
BR2			53.086***
			(15.184)
_cons	0.007	-1.819***	-2.591***
	(0.016)	(0.086)	(0.105)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.107	0.130	0.180

4.2.2. Lag model

Existing literature indicates that corporate green innovation activities require sufficient time accumulation (Shi and Zhou, 2024). From the time a company faces biodiversity risks to the initiation of innovation and R&D, and then to the realization of green innovation output, there is a certain time process involved. To further test for potential reverse causality that could lead to estimation bias, we explored the delayed impacts of corporate biodiversity risks on green innovation. Table 5 implies that both one-period and two-period lagged biodiversity risks positively influence *GIno*. The robustness of our benchmark regression is substantiated.

Table 5

Lag model.

Variables	(1) GIno	(2) GIno
L.BR	0.036***	
	(0.009)	
L2.BR		0.037***
		(0.009)
_cons	-2.634***	-2.757***
	(0.114)	(0.122)
Controls	Yes	Yes
Year FE	Yes	Yes
Ind FE	Yes	Yes
N	31722	28289
R^2	0.184	0.186

4.3. Endogeneity issue: Instrumental variable regression

Given the potential endogeneity from reverse causality, we select the forest cover rate (FCR) of the city where the enterprises are sited as instrumental variable (IV) and then proceed with instrumental variable two-stage least squares regression (IV-2SLS). The reasons why we choose it are below: regarding relevance, the biodiversity risk faced by enterprises is closely related to the forest cover rate of their city. Areas with higher forest cover rates can typically provide more ecosystem services, such as, climate regulation, water treatment, and nutrient cycling. These functions benefit urban biodiversity (Jinsuk and Chan-Ryul Park, 2024), thereby affecting the biodiversity risk faced by enterprises. In terms of exogeneity, there is typically no direct connection between the city’s forest cover rate and the firm's green innovation activities. The reason is that the forest coverage rate of a city is largely determined by regional environment and planning policies, which are external factors beyond the operations or strategic decisions of any single enterprise (Tian and Chen, 2025).

Therefore, although the forest cover rate has a certain impact on the biodiversity risk encountered by enterprises, it has no direct impact on corporates' green innovation endeavors, reducing reverse causality concerns.

The first phase of the instrumental variable regression model is:

$$BR_{i,t} = \beta_0 + \beta_1 FCR_{i,t} + \beta_2 Control_{i,t} + yeardum + inddum + \varepsilon_{i,t} \quad (9)$$

In the second stage, we use the fitted values of biodiversity risk as explanatory variables to estimate model (3). Table 6 presents the IV regression outcomes. The IV coefficient in the initial regression stage is statistically significant in column (1), suggesting a robust link between the instrumental variable and biodiversity risk. Columns (2) and (3) reveal that the regression outcomes in the second stage align with the basic regression results, thereby corroborating that biodiversity risk can foster $GIno$ level, even after considering endogeneity. Moreover, the Kleibergen-Paap rk LM statistic is 21.488, while the Kleibergen-Paap rk Wald F statistic (21.003) exceeds 16.38, thereby refuting the hypotheses of inadequate identification and weak instruments. These test results demonstrate that the instrumental variable we selected is valid and reliable, and H1 remains valid.

Table 6

IV approach results.

Variables	(1) BR	(2) GIno	(3) GIno
BR		1.355***	0.040***
		(0.428)	(0.008)
IV	0.000633***		
	(0.000137)		
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
IndFE	Yes	Yes	Yes
N	35529	35529	35529
Kleibergen–Paap rk LM		21.488	
Cragg-Donald		21.003	
Wald F		16.38	

4.4. Heterogeneity test

4.4.1. High technology industry

High-tech enterprises are the leading forces of China's technological innovation and to some extent drive the country's green innovation process (Zou et al., 2022). Compared to traditional non-tech companies, high-tech companies have greater advantages, such as stronger technical capabilities and greater advantages in resources, technology, and talent (Kirner et al., 2009), making it easier for them to master cutting-edge green technologies (Ren et al., 2024). Moreover, intense market competition compels them to continuously pursue green innovation in order to boost their competitiveness and sustainable development capabilities (Luo and Yin, 2024). Building on this insight, we categorize companies in industries such as software and information technology services, computers, and research and experimental development as high-tech companies, with the remainder as non-high-tech companies (Liu et al., 2020). Columns (1) and (2) of Table 7 imply that the coefficient of BR for high-tech companies is 0.038, while for non-high-tech companies it is 0.033, both significant. This indicates that the biodiversity risk is more pronounced in high-tech enterprises. This suggests that the promoting impact of biodiversity risk on $GIno$ is more remarkable in high-tech enterprises, likely because their organizational structure, core technology, business model, and employee knowledge structure are more favorable for implementing green innovation projects.

4.4.2. Ownership

Considering the institutional context of China, there are certain differences in the role of biodiversity risks of state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs) in promoting green innovation. The green practices of Chinese SOEs are often policy-oriented. Moreover, their resource and financial advantages (Zhang and Liu, 2016) enable them to achieve a higher green innovation level overall. Thus, the impact of biodiversity risks on SOEs may be less apparent. In contrast, non-SOEs frequently encounter more severe market competition and financial limitations. In order to build a stronger reputation, earn the trust of stakeholders, and secure additional resources, they might be more inclined to pursue green innovation initiatives with the aim of strengthening their competitive advantage.

To verify this hypothesis, we conduct regression analyses on SOEs and non-SOEs respectively. Columns (3) and (4) in Table 7 imply that the promoting effect of SOEs is insignificant. It might because of the characteristics of SOEs' R&D

activities, which are heavily influenced by government intervention and typically involve long-term planning. As a result, they are less likely to undergo substantial changes in response to a single risk event. Conversely, biodiversity risks significantly impact non-SOEs' green innovation activities. This suggests that non-SOEs possesse a stronger drive to participate in green innovation as a reaction to biodiversity risks, presumably because their innovation strategies are more sensitive and adaptable to such environmental challenges-biodiversity risks.

4.4.3. Industry competition

Facing fierce market competition, companies can only achieve long-term development by continuously innovating and implementing green innovation development strategies. At the same time, such companies will prioritize gaining the support of stakeholders to secure more substantial resource backing, which aids in their green innovation efforts. Studies have indicated that companies will actively pursue innovation when competition pressures significantly increase. (Aghion et al., 2013; Amore and Bennedsen, 2016). We categorize sample companies into high-industry-competition and low-industry-competition firms using the median Herfindahl-Hirschman Index (HHI) as the criterion and re-estimates model (1). The findings in column (5) and (6) of Table 7 reveal that the BR coefficient companies in low-competition industries stands at 0.024, whereas rises to 0.052 for those in more competitive ones, with both coefficients being significantly positive. This suggests that the influence of biodiversity risks on $GIno$ is more notable as industry competition intensifies. Firms under higher competitive pressure tend to be more proactive in innovating as a means of addressing the biodiversity risk they face.

4.4.4. Financing constraint

Corporate innovation typically requires substantial financial support (Chava et al., 2013; Wan, et al.), because of the long cycles, high risks, and irreversibility of R&D. When funding is insufficient to cover R&D expenses, financing constraints can amplify a company's financial risks and diminish its risk-taking capacity (Giebel and Kraft, 2019; Yang and Hui, 2024), thereby hindering green innovation. Thus, when facing biodiversity risks, companies with less severe financing constraints tend to be better positioned and more capable of pursuing specific green innovation initiatives. Based on this hypothesis, we used the median of the SA index to categorize sample companies into high-financing-constraint and low-financing-constraint groups (Kim and Park, 2015). Column (7) and (8) in Table 7 reveals that for firms with lower financing constraints, the green innovation effect of biodiversity risk appears to be stronger than that for firms facing higher financing constraints. This may be because when firms face high financing constraints, they struggle to support the funding required for green innovation in response to biodiversity risks, thereby showing a more passive attitude toward green innovation activities. In contrast, when firms face low financing constraints, they can leverage their stronger funding acquisition capabilities to support green innovation in response to biodiversity risks, thereby mitigating the negative impacts of such risks.

Table 7

Heterogeneity analysis.

	High_tech	Non_tech	SOEs	non- SOEs	High_HHI	Low_HHI	High_SA	Low_SA
	(1)	(2)	(3)	(4)	(5)	（6）	（7）	（8）
Variables	GIno	GIno	GIno	GIno	GIno	GIno	GIno	GIno
BR	0.037**	0.033***	0.018	0.048***	0.052***	0.024**	0.035**	0.046***
	(0.012)	(0.008)	(0.013)	(0.010)	(0.012)	(0.010)	(0.011)	(0.012)
_cons	-3.906***	-0.907***	-2.526***	-2.462***	-2.700***	-2.501***	-2.206***	-2.708***
	(0.162)	(0.107)	(0.155)	(0.151)	(0.158)	(0.142)	(0.143)	(0.152)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	20907	14622	14054	21474	18297	17226	18595	16931
R^2	0.155	0.232	0.232	0.172	0.168	0.194	0.161	0.224

5. Further analysis

5.1. Test of mediating effects

5.1.1 External analyst attention

By increasing analyst attention to form an effective external supervisory mechanism and catering to the motivations of stakeholders, companies can enhance their level of green innovation, which is an important mechanism through which biodiversity risks drive corporate green innovation. When considering stakeholders, the influence of individual investors, online media, and other members of the public on corporate innovation and green performance is substantial and should not be underestimated (Liu et al., 2024; Ilhan et al., 2023). Hence, we seek to explore in depth the external supervisory mechanism from the perspective of analyst attention.

The results are in Panel A of Table 8. The regression coefficient for *BR* in column (1) is significantly positive, suggesting that biodiversity risk can drive corporate green innovation, and thus we delve into its underlying mechanism; Column (2) implies that the coefficient (0.071) is with a significance level of 1%, thus biodiversity risk can increase analyst attention; Column (3) indicates that the regression coefficient of *AnaAttention* and *BR* remain significantly positive, which suggests that biodiversity risk can enhance *GIno* by increasing analyst attention. H3a is thereby confirmed.

5.1.2. Internal managerial myopia

As previously discussed, while biodiversity risk strengthens external oversight mechanisms, it also exerts a profound impact on the internal management models of enterprises. The biodiversity risk faced by enterprises, though presenting challenges, simultaneously offers opportunities for curbing managerial myopia and promoting sustainable development through external oversight mechanisms. Stakeholders, by enhancing supervision and accountability, urge companies to integrate biodiversity into their decision-making frameworks, thereby prompting companies to take proactive steps in environmental protection, resource utilization, and green innovation. In other words, biodiversity risk can effectively curb the short-sighted behavior of management, preventing the neglect of long-term green innovation strategies due to an excessive pursuit of short-term benefits (Sun and Liu, 2016). Hence, we seek to explore in depth the internal management mechanism from the perspective of management myopia.

The results are in Panel B of Table 8. Distinct from Panel A, the regression coefficient of *Myopia* (-0.349) is significantly negative, suggesting that biodiversity risk can enhance *GIno* by curbing management myopia. H3b is confirmed.

Table 8

Test of mediating effects.

Panel A: External analyst attention.			
	(1)	(2)	(3)

Variables	GIno	AnaAttention	GIno
BR	0.040***	0.071***	0.037***
	(0.008)	(0.011)	(0.008)
AnaAttention			0.049***
			(0.004)
_cons	-2.543***	-11.265***	-1.986***
	(0.106)	(0.109)	(0.114)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.180	0.460	0.184

Panel B: Internal managerial myopia.

	(1)	(2)	(3)
Variables	GIno	Myopia	GIno
BR	0.040***	-0.002***	0.040***
	(0.008)	(0.000)	(0.008)
Myopia			-0.349***
			(0.087)
_cons	-2.543***	0.057***	-2.502***
	(0.106)	(0.005)	(0.106)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.180	0.107	0.180

5.2. Test of moderating effects

5.2.1. CEO green experience and government green subsidy

CEOs who have green experience are equipped with a diverse set of “green” knowledge assets, such as awareness of environmental impacts, a values-driven approach to sustainability, and extensive experience in environmental practices. These qualities equip them to tackle environmental issues with a proactive mindset, seeking to create a win-win relationship between economic development and green ecology. They tend to actively recognize market opportunities and resources stemming from ecological challenges and incorporate green innovation into higher-level corporate strategies. This forward-looking leadership not only helps companies address current environmental challenges but also builds a solid base for their long-term development, driving the company to steadily advance on the path of green transformation (Banerjee, 2001). Additionally, government green subsidies can offer a vital influx of resources that facilitates companies' engagement in green innovation (Liu et al., 2019). When facing biodiversity risks, the green experience of CEOs and government green subsidies support companies in conducting green innovation from the inside and the outside, respectively.

To examine how CEOs' green experience and government green subsidies moderate the impact of biodiversity risk on $GIno$, we introduce interaction terms between biodiversity risk and the moderating variables. The outcomes in Panels A and B of Table 9 imply that the coefficients of the interaction terms $BR \times Green$ is 0.076 and 0.157 for $BR \times ES$, both of which are highly significant. This reveals that the CEO green experience and government green subsidies can positively mediate the link between biodiversity risk and $GIno$. Furthermore, only the coefficient for $GIno\_Subst$ is significant, showing that the positive moderating effects of CEO green experience and government green subsidies are primarily reflected in substantive green innovation activities. H4 is thereby confirmed.

5.2.2. Technological diversification

Technological diversification can cause a firm's innovative efforts to become fragmented, as it spreads the company's resources and focus across various technological domains. As a result, the resources that might otherwise have been directed toward biodiversity projects are channeled elsewhere, diminishing the company's concentration and investment in green innovation (Shin and Jalajas, 2010).

To test the moderating effect of technological diversification, the same method of using interaction terms for regression analysis was employed, and the results can be found in Panel C of Table 9. The coefficient of $BR \times TD$ (-0.484) is significantly negative in column (1), indicating that technological diversification lessens the positive impact of biodiversity risk on $GIno$. Furthermore, technological diversification can mitigate the active effect of biodiversity risk on green innovation, across both strategic and substantive dimensions. H5 is thereby confirmed.

Table 9

Test of moderating effects.

Panel A: CEO green experience.

Variables	(1) GIno	(2) GIno_Strat	(3) GIno_Subst
BR	0.035***	0.005	0.030***
	(0.008)	(0.006)	(0.006)
BR×Green	0.076**	0.054**	0.062**
	(0.027)	(0.019)	(0.022)
_cons	-2.536***	-1.349***	-2.225***
	(0.106)	(0.074)	(0.087)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.180	0.153	0.146

Panel B: Government green subsidy.

Variables	(1) GIno	(2) GIno_Strat	(3) GIno_Subst
BR	0.036***	0.006	0.031***
	(0.008)	(0.006)	(0.006)
BR×GS	0.157**	0.087**	0.102**
	(0.059)	(0.043)	(0.046)
_cons	-2.550***	-1.355***	-2.234***
	(0.106)	(0.071)	(0.087)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.180	0.152	0.160

Panel C: Technological diversification.

Variables	(1) GI	(2) GIno_Strat	(3) GIno_Subst
BR	0.225***	0.088***	0.201***
	(0.016)	(0.011)	(0.013)
BR×TD	-0.484***	-0.210***	-0.437***
	(0.027)	(0.018)	(0.022)
_cons	-2.334***	-1.272***	-2.087***
	(0.118)	(0.080)	(0.097)

Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes
N	35529	35529	35529
R^2	0.175	0.146	0.163

6. Conclusion

Utilizing a sample of listed companies during 2009—2022, this study empirically examine the relationship and underlying mechanisms between biodiversity risk and corporate green innovation in Chinese corporates. We include that biodiversity risk notably boosts corporate green innovation, primarily manifesting in high-quality substantive green innovation activities. Biodiversity risk primarily increases corporate green innovation via the external supervisory mechanism of increased analyst attention and the internal management mechanism of dampened managerial myopia. Government green subsidies and CEOs' green experience serve as a negative moderator between biodiversity risk and green innovation, whereas technological diversification exerts a negative moderating effect. It should be highlighted that high-tech firms, non-SOEs, and those in highly competitive industries and with lower financing constraints are more inclined to address biodiversity risks through green innovation.

The conclusions drawn from this study provide policy recommendations for corporate decision-makers, market investors, and policymakers regarding the enhancement of green innovation and the management of biodiversity risks. First, companies should choose technological diversification strategies based on their own development and introduce CEOs with green experience. While avoiding excessive dispersion of effort and resources, companies should enhance their identification and investment in biodiversity risks, thereby promoting green innovation and sustainable development. Moreover, for corporate managers, it is necessary to re-examine their decision-making patterns within the complex internal and external environments, and to balance short-term interests with long-term strategies in order to achieve high-quality and sustainable development for the enterprises. Secondly, for market investors, it is essential to regard corporate green performance as a crucial investment consideration, prioritizing companies that excel in green innovation and sustainable development. By acting as vigilant monitors, investors can encourage firms to adopt more environmentally friendly business strategies, thereby promoting sustainable practices and mitigating biodiversity risks. Finally, policymakers should fully leverage their guiding role by continuing to increase fiscal support for corporate green R&D efforts. By improving the policy and funding support system, they can assist enterprises in achieving green transformation, establish effective innovation incentive mechanisms, and enhance companies' willingness to engage in green innovation. This will not only drive businesses toward low-carbon and green development but also provide strong support for sustainable economic growth. Moreover, the government should prioritize high-tech and highly competitive sectors when crafting and executing environmental policies to further drive green innovation and sustainable development.

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