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How do executives respond to biodiversity risk? Evidence from opportunistic stock selling

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ABSTRACT

Biodiversity loss is increasingly recognized as a critical environmental challenge with significant implications for corporate governance. Using data from Chinese A-share listed companies from 2010 to 2022, we explore the impact of biodiversity risk on executive opportunistic stock selling. Our results show that biodiversity risk, particularly biodiversity regulation risk, reduces executive opportunistic stock selling, and this finding is robust to the Heckman two-step model and instrumental variable analysis. Mechanism analysis suggests that biodiversity risk influences executive behavior through firm value and the divestment of long-term institutional investors, while heterogeneity analysis indicates that the effects are more pronounced in firms with more institutional investor site visits, stricter environmental regulations and lower media attention. We supplement the biodiversity risk literature and provide a fresh perspective for understanding executive decision-making.

1. Introduction

Biodiversity loss has emerged as one of the most pressing global challenges, with profound implications not only for ecosystems but also for economic stability and corporate governance. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), human activities have altered 75 % of terrestrial and 66 % of marine environments, placing nearly one million species at risk of extinction. This decline in biodiversity has significant economic consequences, as an estimated $44 trillion in economic value—more than half of global GDP—is dependent on natural ecosystems and the services they provide (WEF, 2020). Industries ranging from agriculture to pharmaceuticals rely on biodiversity for resources like fertile soils, clean water, and raw materials. These ecological services are now under threat, leading to both physical and transition risks for businesses that must adapt to the regulatory and market changes arising from biodiversity loss (Giglio et al., 2023). Amid growing awareness of these risks, biodiversity risk has emerged as an important environmental risk factor for corporations, particularly following international agreements like the UN Biodiversity Conference (COP15). Biodiversity risk refers to the potential economic and financial consequences

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arising from the loss or degradation of biodiversity, encompassing physical risks—such as the depletion of natural ecosystems, species extinction, and ecosystem service disruption—as well as transition risks associated with regulatory, market, and policy responses to biodiversity loss (Garel et al., 2024; Giglio et al., 2023). Firms now face increasing pressure from stakeholders—ranging from regulators to investors—to mitigate their negative impact on ecosystems (Houdet et al., 2012; Carvalho et al., 2023).

However, despite its importance, biodiversity risk remains under-researched compared to climate change risk, primarily due to the challenges in measurement and complexity. Unlike climate risk, which benefits from relatively established metrics and research frameworks, biodiversity risk lacks standardized indicators, making it harder to quantify and integrate into corporate risk assessments (Schaltegger et al., 2023). This gap has resulted in biodiversity risk receiving less attention from both academic and financial communities (Krueger et al., 2020; Stroebel and Wurgler, 2021). Recent progress, such as the systematic quantification methods introduced by Giglio et al. (2023), provides new opportunities for researchers and practitioners to address this gap, offering a clearer pathway for integrating biodiversity considerations into corporate governance and decision-making frameworks.

The literature on biodiversity risk and its financial implications has evolved significantly, covering multiple dimensions such as corporate audit fees, firm performance, cash holdings, and investment decisions (Steindl et al., 2024; Bach et al., 2024; Ahmad and Karpuz, 2024; Trinh, 2023). Although these studies address different financial aspects, they collectively illustrate how biodiversity risk has become an important factor across multiple areas of corporate decision-making. While Steindl et al. (2024) highlight the growing role of auditors in pricing biodiversity risk, Ahmad and Karpuz (2024) and Bach et al. (2024) extend this understanding by exploring cash management and firm performance respectively, showing that biodiversity risk influences both liquidity and profitability. Additionally, Bach et al. (2024) find that biodiversity risk negatively impacts firm performance, suggesting that biodiversity exposure poses significant financial risks to firms, particularly those in biodiversity-sensitive industries.

Carvalho et al. (2023) emphasize that while some companies have adopted biodiversity policies, much of their enterprise value remains exposed to unmanaged biodiversity risks, highlighting the need for strategic responses from firms. Bassen et al. (2024) link corporate biodiversity management to stock price crash risk, demonstrating that firms with robust biodiversity strategies tend to face lower risks of abrupt stock price declines. Cosma et al. (2024) introduce the Corporate Biodiversity Footprint as a measure of biodiversity risk, and find that biodiversity loss caused by firm activities negatively affects firm value. Their findings emphasize the systemic nature of biodiversity loss and its measurable impact on firm value, strengthening the argument for integrating biodiversity into corporate strategies. Naffa and Czupy (2024) identify the presence of a biodiversity risk premium, indicating that investment portfolios with biodiversity considerations tend to yield lower risk-adjusted returns, which points to market pricing dynamics that reflect biodiversity-related risks. In a broader context, Lorente et al. (2023) demonstrate that renewable energy adoption and economic complexity can reduce biodiversity risks, particularly in developing regions like China. Collectively, these studies underscore the importance of integrating biodiversity concerns into financial decision-making and the diverse range of responses from investors and companies.

Based on the previous literature, biodiversity risk has been widely studied for its impact on financial outcomes such as firm performance, financial stability, and stock value, all of which inevitably shape executive decision-making. Executives often hold significant shares in their companies, linking their personal financial outcomes directly to the company's stock performance. When biodiversity risk leads to fluctuations in firm value or stock price, executives face critical decisions: should they continue to hold their shares or engage in stock selling to capitalize on potential gains or mitigate losses? These decisions are particularly complex, as they involve balancing personal financial interests with long-term corporate health and investor trust. Understanding how biodiversity risk influences these stock selling behaviors, provides valuable insights into corporate governance and opportunistic executive actions.

The existing literature on executive opportunistic stock selling highlights both internal corporate governance mechanisms and external conditions that shape insider trading behavior. Ali and Hirshleifer (2017) show that opportunistic insiders often engage in misconduct, such as earnings management, while Goergen et al. (2019) demonstrate that well-connected directors can achieve higher profitability through insider trading. Li and Ji (2021) emphasize the governance role of multiple large shareholders (MLS) and institutional investors in mitigating opportunistic behaviors. Du et al. (2024) provide evidence from China showing that insiders exploit favorable market conditions through fast sales, but this behavior can be curbed by independent directors and institutional investors. Tirapat and Visaltanachoti (2013) contribute by distinguishing between opportunistic and liquidity-based trades, offering a nuanced understanding of how insiders may exploit market conditions.

On the other hand, studies also examine how external factors influence insider opportunism. Ma et al. (2024) demonstrate that extreme weather, such as rainfall, dampens opportunistic stock selling by executives, extending the concept of governance to environmental constraints. Bushee et al. (2023) reveal that investor conferences provide an opportunity for executives to hype stocks for opportunistic gains, showing how events that increase investor attention can be exploited. Huang et al. (2021) highlight the role of judicial ideology, showing that more liberal judges impose heavier penalties on insider trading, which reduces the occurrence of opportunistic insider sales in those jurisdictions. Luo and Huang (2020) also provide evidence that the coexistence of multiple large shareholders plays a significant role in reducing executive opportunistic selling, reinforcing the governance effect of shareholder structure. Together, these studies depict a complex landscape where both internal governance structures and external pressures shape the extent of executive opportunism. However, there remains a research gap regarding the link between biodiversity risk and executive opportunistic stock selling.

This study aims to fill this research gap by examining the relationship between biodiversity risk and executive opportunistic stock selling behavior, using data from Chinese A-share listed companies from 2010 to 2022. To achieve this, we measure opportunistic stock selling using the methodology of Luo and Huang (2020) and Huddart and Ke (2007), and quantify biodiversity risk through a textual analysis of corporate annual reports, referencing Giglio et al. (2023). The research methodology includes Ordinary Least Squares (OLS) regression as the primary analytical tool, with robustness checks using the Heckman two-step model and instrumental variable (IV)

analysis to address sample selection and endogeneity concerns. Our findings indicate that biodiversity risk significantly reduces executive opportunistic stock selling, primarily by lowering firm value and triggering divestment by long-term institutional investors. The suppressive effects are more pronounced in firms with more institutional investor site visits, stricter environmental regulations and low media attention. Moreover, we find that biodiversity regulation risk has an even greater suppressive effect compared to general biodiversity risk. These results underscore biodiversity risk as an often overlooked but significant factor in executive decision-making and corporate governance.

This paper makes several key contributions to the existing literature on biodiversity risk and executive opportunism. First, it provides a unique empirical analysis linking biodiversity risk with executive behavior. Among the relatively few studies on biodiversity risk, this paper is the first to connect biodiversity risk specifically to executive actions, thereby introducing an important new dimension to biodiversity risk literature beyond the typical financial impacts. Second, this paper expands the scope of research on opportunistic stock selling by integrating biodiversity risk into the analysis, which has traditionally focused on internal governance, external supervision, ownership structure, and market conditions. This integration highlights how environmental challenges such as biodiversity loss can serve as external shocks that influence executive decision-making, thereby enriching our understanding of the drivers of executive opportunism. Lastly, the study demonstrates that biodiversity risk can serve as an exogenous factor that suppresses opportunistic executive behavior, particularly in contexts where environmental pressures are strong. This finding underscores biodiversity risk not only as a financial challenge but also as a governance mechanism that encourages more cautious and responsible behavior among executives. These insights offer practical implications for enhancing corporate governance strategies, particularly for firms seeking to align their executive decision-making with sustainable environmental practices.

The paper is structured as follows: Section 2 outlines the hypotheses regarding biodiversity risk and its impact on firm value and institutional ownership. Section 3 describes the data, variable construction, and descriptive statistics. Section 4 presents the empirical results, covering baseline regressions, robustness tests, mechanism analyses, and heterogeneity analysis. Section 5 concludes with a summary of the main findings and their implications for corporate governance and environmental risk.

2. Hypothesis development

2.1. Biodiversity risk and firm value

Biodiversity risk poses a substantial threat to firm value by increasing operational uncertainty and cost pressures. Cosma et al. (2024) provide core evidence that biodiversity loss, quantified through the Corporate Biodiversity Footprint, significantly reduces firm value, highlighting the systemic financial implications of biodiversity risks. Similar to climate change, biodiversity loss jeopardizes firms' competitiveness, profitability, and long-term viability (Velte, 2023; Ali et al., 2024; WEF, 2020). The degradation of biodiversity disrupts the sustainable supply of natural resources and undermines ecosystem services (Bach et al., 2024; Steindl et al., 2024), leading to higher raw material costs and supply chain risks (Ali et al., 2024; WEF, 2020). This is especially detrimental for industries dependent on natural resources, where physical biodiversity risks directly threaten core production capabilities and long-term profitability. Additionally, firms face transition risks driven by stakeholder pressures, such as regulatory agencies, consumers, investors, and suppliers, which demand a shift toward biodiversity-friendly practices (Steindl et al., 2024). As environmental regulations become stricter, firms with high biodiversity exposure are subjected to more stringent oversight, leading to increased legal risks and regulatory costs if they fail to manage biodiversity properly (Giglio et al., 2023). Consequently, market investors are likely to downgrade their expectations of future cash flows and profitability for firms facing significant biodiversity risks, leading to a reduction in firm value.

The decline in firm value has a direct impact on executives' stock-selling behavior. According to agency theory, executives possess superior internal information and tend to engage in opportunistic stock selling when the stock price is high, aiming to maximize their personal gains. However, when firm value declines due to biodiversity risk, falling stock prices reduce the potential gains from stock sales (Pham, 2022). Markets are highly sensitive to executive opportunism, particularly when firm value is low, and may interpret stock sales during periods of depressed stock prices as a signal of executives' negative outlook on the company's future prospects, thereby exacerbating downward pressure on the stock (Ali and Hirshleifer, 2017). Furthermore, executive decisions influence both internal operations and market perceptions of stock price transparency. When biodiversity risk drives down stock prices, the market's negative interpretation of executive stock sales becomes more pronounced. As a result, executives may opt to reduce or delay opportunistic stock selling to avoid diminishing returns and negative market reactions to their actions (Withisuphakorn and Jiraporn, 2015; Ma et al., 2024).

2.2. Biodiversity risk and long-term institutional investors divestment

Institutional investors play a critical role in corporate governance due to their substantial voting power and influence over strategic decisions (García-Sánchez et al., 2022a; Kordsachia et al., 2022). These investors can be broadly categorized into short-term and long-term investors, with the latter focusing more on a firm's sustainability and long-term viability. Long-term institutional investors, as opposed to their short-term counterparts, are more likely to advocate for corporate transparency and responsible environmental practices, including biodiversity risk management (García-Sánchez et al., 2022a, 2022b). They tend to monitor management decisions closely, particularly regarding biodiversity disclosures, as they view such initiatives as crucial for ensuring the firm's long-term stability and alignment with sustainable business practices (Ali et al., 2024). However, when a firm fails to adequately address biodiversity risks, long-term institutional investors may resort to "voting with their feet," meaning they withdraw their investments (Cohen et al., 2023; Wang et al., 2023), signaling a lack of confidence in the firm's ability to manage such risks.

The withdrawal of long-term institutional investors serves as a strong negative signal to the market, highlighting potential instability or future financial difficulties for the company. According to market signal theory, this divestment can lead to further negative perceptions, driving down the company's stock price as investors revise their expectations for future firm value (Goldstein et al., 2022; Parrino et al., 2003). In response to this declining market confidence, executives may be incentivized to exercise self-restraint and reduce their opportunistic stock selling behaviors to prevent exacerbating the situation (Gilje et al., 2020; Contreras and Marcet, 2021). Selling stocks in the wake of long-term institutional divestment could be interpreted as a sign that the management lacks confidence in the company's future, potentially accelerating the stock's decline. To maintain market stability and demonstrate their long-term commitment to the company, executives may limit their stock sales to project an image of responsibility and dedication to the firm's future.

Based on the above discussion, we hypothesize that:

Hypothesis 1. Biodiversity risk discourages opportunistic stock selling behaviors of executives.

Hypothesis 2. Biodiversity risk reduces firm value, thereby lowering executives' incentive for opportunistic stock selling.

Hypothesis 3. Biodiversity risk prompts divestment by long-term institutional investors, further discouraging executives from opportunistic stock selling.

3. Data and variables

3.1. Sample and data

This study utilizes a sample of Chinese A-share listed companies from 2010 to 2022. The time frame is selected to avoid the impacts of the 2008–2009 financial crisis and to account for China's new accounting standards implemented in 2007. Biodiversity risk data are sourced from the annual reports of listed companies, while data on opportunistic stock selling behaviors of executives are obtained from the CSMAR (China Stock Market & Accounting Research) database. Additional company-specific information comes from both the CSMAR and CNRDS (Chinese Research Data Services) databases. We exclude firms in the financial industry, ST/*ST companies, and firms with missing data. All continuous variables are winsorized at the 1 % level on both tails. After these adjustments, the final sample consists of 22,086 firm-year observations.

3.2. Dependent variables: Opportunistic stock selling behaviors of executives

Following the methodology of Luo and Huang (2020) and Huddart and Ke (2007), this study constructs the variable representing opportunistic stock selling behaviors of executives by excluding block trades, negotiated transfers, and stock-based compensation sales. Specifically, the event study method is applied to identify opportunistic stock sales. The event window is centered around the stock sale announcement date, with an estimation period of [−150, −31] trading days prior to the announcement. During this period, the abnormal returns (AR) are calculated using a standard market model to assess the stock price performance and any excess returns associated with each sale.

A stock sale is classified as opportunistic if it predicts a negative stock return within the subsequent month. Conversely, stock sales that do not predict negative returns are considered routine. At the firm-year level, we aggregate all opportunistic sales by calculating the total amount of stock sold by executives (*Sell*) and the total number of opportunistic sales (*SellTimes*). Both variables are then log-transformed. For firm-year observations with no stock sales, following Luo and Huang (2020), the dependent variable is set to zero.

3.3. Independent variables: Biodiversity risk

To construct the biodiversity risk variable, this study employs a textual analysis approach based on the methodology of Giglio et al. (2023). Specifically, the textual analysis focuses on the "Management Discussion and Analysis" (MD&A) section of annual reports, rather than analyzing the entire report. The rationale for selecting the MD&A section is to avoid the interference of irrelevant or overly technical information that might be present in other sections of the report. The MD&A is expected to provide deeper insights into the company's strategy, operations, and risks, making it a more representative source for understanding the company's position on biodiversity issues (Mayew et al., 2015; Chen and Li, 2015).

Following Giglio et al. (2023), a Biodiversity Dictionary is constructed to capture biodiversity-related terms. The dictionary includes terms such as: "biodiversity," "ecosystem(s)," "ecology (ecological)," "habitat(s)," "species," "rainforest(s)," "deforestation," "fauna," "flora," "marine," "wildlife," "coral," "aquatic," "desertification," "carbon sink(s)," "ecosphere," and "biosphere." These terms were selected based on their cosine similarity to the word "biodiversity" using Google's word2vec model. Each sentence in the MD&A section is analyzed, and a sentence is identified as biodiversity-related if it contains at least one term from the dictionary, excluding irrelevant combinations such as "software ecosystem." A detailed version of the dictionary is provided in Online Appendix Table A1. For example, the sentence: "*The global annual production of plastic waste is approximately 300 million tons, with a significant amount entering the soil and oceans, ultimately forming white pollution that poses severe threats to ecological protection and biodiversity*," contains the term "biodiversity" and is therefore classified as a biodiversity-related sentence. Online Appendix Table A2 provides additional examples. For each company, if the MD&A section contains at least two biodiversity-related sentences, the company is assigned a Biodiversity Risk Score (bdr1) of "1" for that year. If no biodiversity-related sentences are present, the company is assigned a score of

"0."

Additionally, this study constructs a Biodiversity Regulation Risk Score (bdr2) to capture regulatory risks related to biodiversity. To achieve this, we extend Giglio et al.'s method by using word2vec to adapt the model to Chinese terms. This approach expands the biodiversity regulation dictionary to account for linguistic differences, particularly in cases where a single English word corresponds to multiple Chinese translations. The biodiversity regulation risk score is calculated by identifying biodiversity-related sentences that also include regulatory terms such as "law(s)," "regulation," or "restriction." For example, the sentence: "*With the advancement of high-quality fishery development, continuous strengthening of environmental resource protection, implementation of marine seasonal fishing bans, expansion of closed fishing seasons in open sea areas, and increased supervision of deep-sea fisheries, the fishery sector is expected to maintain steady growth*," contains the term "marine" along with related ecological terms such as "environmental," classifying it as a biodiversity-related sentence. Furthermore, since it also includes the term "supervision," it is classified as a biodiversity regulation-related sentence. If a company's MD&A section contains at least two biodiversity-related sentences and at least one biodiversity regulation-related sentence, the company is assigned a bdr2 score of "1"; otherwise, the score is "0."

By applying this textual analysis method, the study constructs the two key independent variables, *bdr1* and *bdr2*, which quantify the extent to which firms disclose biodiversity risks and their regulatory implications.

3.4. Control variables

Following the approach of prior studies such as Luo and Huang (2020) and Ma et al. (2024), this paper incorporates several control variables to account for factors influencing opportunistic stock selling behaviors of executives. The control variables include firm size (*Size*), leverage (*Lev*), firm performance (*ROA*), firm age (*Age*), ownership concentration (*TOP1*), proportion of independent directors (*Indep*), CEO duality (*Dual*), state ownership (*SOE*), management shareholding (*Mshare*), institutional investor shareholding (*Inst*), board size (Board), analyst coverage (*Analyst*), earnings management (*DA*), cash dividends (*CashDividends*), and executive compensation (*TOP3Salary*). These control variables aim to account for key firm characteristics that might impact executive decision-making and the governance environment. Detailed definitions and measurements of these variables are provided in Table A3 in the appendix.

3.5. Descriptive statistics

Table 1 presents descriptive statistics for our sample. The mean value of *Sell* is 3.940, with a standard deviation of 6.631, reflecting significant variability in the amount of stock sales across firms. This suggests that opportunistic stock selling is widespread but varies considerably between firms. The mean of *SellTimes*, 0.394, with a standard deviation of 0.753, further highlights differences in the frequency of opportunistic selling across companies. This variability implies that, in some firms, executives engage in more frequent opportunistic selling than others, reflecting differences in corporate governance or market conditions. For the independent variables, *bdr1* and *bdr2*, the mean values are 0.175 and 0.141, respectively. This shows that approximately 17.5 % of the firms in the sample disclosed biodiversity-related risks, while 14.1 % of firms reported biodiversity regulation risks in their annual reports. These numbers suggest a relatively low but noteworthy level of biodiversity risk awareness among Chinese firms. The statistics for control variables align with findings from existing research.

Table 1
Descriptive statistics.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	N	Mean	SD	Min	Median	Max
Sell	22,086	3.940	6.631	0	0	25.67
SellTimes	22,086	0.394	0.753	0	0	4.466
bdr1	22,086	0.175	0.380	0	0	1
bdr2	22,086	0.141	0.348	0	0	1
Size	22,086	22.44	1.294	19.84	22.26	26.27
Lev	22,086	0.425	0.200	0.056	0.420	0.912
ROA	22,086	0.047	0.056	−0.265	0.044	0.197
Age	22,086	9.715	7.108	1	8	28
TOP1	22,086	0.348	0.148	0.083	0.328	0.750
Indep	22,086	0.375	0.053	0.333	0.333	0.571
Dual	22,086	0.287	0.452	0	0	1
SOE	22,086	0.340	0.474	0	0	1
MShare	22,086	0.142	0.197	0	0.012	0.705
Inst	22,086	0.460	0.249	0.004	0.486	0.930
Board	22,086	2.136	0.198	1.609	2.197	2.708
Analyst	22,086	1.740	1.113	0	1.792	3.829
DA	22,086	0.012	0.097	−0.355	0.014	0.303
CashDividends	22,086	0.798	0.402	0	1	1
TOP3Salary	22,086	14.63	0.729	12.71	14.60	16.59

This table presents the descriptive statistics for the main variables used in the study. The statistics are calculated from a sample of 22,086 firm-year observations from Chinese A-share listed companies between 2010 and 2022. All continuous variables are winsorized at the 1 % level to mitigate the influence of outliers.

4. Empirical results

4.1. Baseline regression

To empirically analyze the impact of biodiversity risk on executives' opportunistic stock selling behaviors, we construct the following baseline regression model:

$$IT_{i,t} = \beta_0 + \beta_1 bdr_{i,t} + \beta_i Controls_{i,t} + \delta_j + \varphi_t + \varepsilon_{it}$$

In this model, the dependent variable $IT_{i,t}$ represents opportunistic stock selling behaviors by executives, which are measured through two proxies: the total amount of opportunistic stock sales (*Sell*) and the total number of opportunistic stock sale transactions (*SellTimes*). The main independent variable $bdr_{i,t}$ captures biodiversity risk, which is assessed using two measures: biodiversity risk (*bdr1*) and biodiversity regulation risk (*bdr2*). $Controls_{i,t}$ represents a set of firm-level control variables. δ_j denotes industry fixed effects, and φ_t captures year fixed effects to account for industry-specific and time-specific unobserved factors. The standard errors are clustered at the industry level to control for cross-sectional dependence within industries.

Table 2 presents the baseline regression results, which investigate the impact of biodiversity risk on executives' opportunistic stock selling behaviors. In Columns (1) and (2), the dependent variables are *Sell* and *SellTimes*, respectively. The independent variable, biodiversity risk (*bdr1*), shows a negative and statistically significant association across both specifications. Specifically, the coefficient for *bdr1* in Column (1) is −0.257, indicating that firms facing biodiversity risk experience a reduction in opportunistic stock sales by

Table 2
Baseline regression.

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1	−0.257***	−0.035***		
	(0.092)	(0.011)		
bdr2			−0.290**	−0.034**
			(0.131)	(0.014)
Size	−0.222***	−0.030***	−0.223***	−0.031***
	(0.073)	(0.009)	(0.073)	(0.009)
Lev	0.247	0.057	0.245	0.057
	(0.331)	(0.042)	(0.331)	(0.043)
ROA	3.378**	0.425**	3.386**	0.426**
	(1.336)	(0.168)	(1.336)	(0.169)
Age	−0.131***	−0.015***	−0.131***	−0.015***
	(0.011)	(0.001)	(0.011)	(0.001)
TOP1	−2.141***	−0.242***	−2.142***	−0.242***
	(0.415)	(0.050)	(0.415)	(0.050)
Indep	−0.517	−0.043	−0.512	−0.042
	(1.504)	(0.147)	(1.506)	(0.147)
Dual	0.002	−0.001	0.000	−0.001
	(0.118)	(0.017)	(0.119)	(0.017)
SOE	−0.889***	−0.093***	−0.889***	−0.093***
	(0.119)	(0.013)	(0.120)	(0.013)
MShare	1.225**	0.183***	1.226**	0.184***
	(0.528)	(0.065)	(0.529)	(0.065)
Inst	−4.009***	−0.376***	−4.007***	−0.376***
	(0.365)	(0.041)	(0.365)	(0.041)
Board	0.974**	0.151***	0.975**	0.151***
	(0.474)	(0.052)	(0.475)	(0.052)
Analyst	0.570***	0.062***	0.570***	0.062***
	(0.058)	(0.006)	(0.058)	(0.006)
DA	−0.098	−0.028	−0.100	−0.028
	(0.551)	(0.072)	(0.553)	(0.072)
CashDividends	0.139	0.017	0.139	0.017
	(0.100)	(0.011)	(0.100)	(0.011)
TOP3Salary	0.450***	0.033**	0.449***	0.033**
	(0.110)	(0.013)	(0.110)	(0.013)
Constant	3.111	0.530**	3.141	0.536**
	(2.237)	(0.242)	(2.225)	(0.241)
Observations	22,084	22,084	22,084	22,084
R-squared	0.161	0.145	0.161	0.145
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

This table reports the results of the baseline regressions exploring the effects of biodiversity risk on executives' opportunistic stock selling behaviors. All regressions include the control variables, industry fixed effect, and year fixed effect. Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

executives of approximately 6.52 % relative to the mean (0.257/3.940). In Column (2), the coefficient for *bdr1* is −0.035, suggesting that higher biodiversity risk is associated with an 8.88 % reduction in the frequency of opportunistic sales relative to the mean (0.035/0.394). These results confirm our hypothesis 1, indicating that firms facing biodiversity risks tend to experience a notable reduction in opportunistic stock sales by their executives. This suggests that biodiversity risk serves as a deterrent to such behaviors.

In Columns (3) and (4), biodiversity risk (bdr1) is replaced by biodiversity regulation risk (bdr2), which captures the regulatory dimension of biodiversity exposure. The results reveal that *bdr2* is also negatively associated with both *Sell* and *SellTimes*, with statistical significance, further supporting our hypothesis. Specifically, the coefficient for *bdr2* in Column (3) is −0.290, indicating that firms facing biodiversity regulation risk experience a reduction in opportunistic stock sales by executives of approximately 7.36 % relative to the mean (0.290/3.940). In Column (4), the coefficient for *bdr2* is −0.034, suggesting that higher biodiversity regulation risk is associated with an 8.63 % reduction in the frequency of opportunistic sales relative to the mean (0.034/0.394). These findings imply that the presence of biodiversity regulation risk significantly diminishes the likelihood of opportunistic sales by executives, likely due to the potential legal and reputational repercussions associated with regulatory non-compliance.

Collectively, these results underscore the significant role of biodiversity risk, particularly regulatory aspects, in mitigating opportunistic stock selling behaviors by executives. Notably, biodiversity regulation risk appears to have a greater impact on reducing such behaviors compared to general biodiversity risk, and the subsequent analysis further supports this conclusion. This highlights biodiversity risk as an emerging and influential dimension of corporate governance.

4.2. Robustness tests

4.2.1. Addressing the potential selection bias

One concern with the baseline analysis is the potential for sample selection bias. Firms' decision to disclose biodiversity risk in their annual reports is influenced by whether the risks are material to their business operations and by the regulatory requirements governing disclosure (Matsumura et al., 2024; Bach et al., 2024). This suggests that companies may self-select into disclosure, meaning the sample may not represent all firms evenly. To address this potential bias, we apply the Heckman two-step selection model, which helps mitigate concerns related to non-random sample selection.

Table 3
Addressing the potential selection bias.

Panel A. Heckman model

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	bdr1	Sell	SellTimes	bdr2	Sell	SellTimes
IndMeanbdr1	3.399***					
	(0.139)					
IndMeanbdr2				3.568***		
				(0.152)		
bdr1		−0.209**	−0.032***			
		(0.097)	(0.011)			
bdr2					−0.282**	−0.035**
					(0.136)	(0.014)
imr		0.406	0.027		0.056	−0.006
		(0.384)	(0.045)		(0.366)	(0.044)
Observations	22,016	22,016	22,016	22,028	22,028	22,028
Pseudo R^2/R^2	0.186	0.161	0.144	0.200	0.161	0.144
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Entropy balance method

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1	−0.306***	−0.039***		
	(0.094)	(0.011)		
bdr2			−0.335**	−0.040***
			(0.133)	(0.014)
Observations	22,084	22,084	22,084	22,084
R-squared	0.165	0.147	0.170	0.151
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

The table presents the results from the Heckman two-stage regression model and the Entropy Balance Method. Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

Panel A of Table 3 reports the results from the Heckman two-step regression model. In the first stage, we use *bdr1* (*bdr2*) as the dependent variable and include the same-year industry mean of *bdr1* (*bdr2*), denoted as *IndMeanbdr1* (*IndMeanbdr2*), as an exclusion restriction variable, along with control variables, to run a probit regression. The resulting inverse Mills ratio (*imr*) is then included in the baseline regression. The findings show that the coefficients for the independent variables remain significantly negative at least the 5 % level, indicating that the main results are robust to potential sample selection bias.

To further address the sample selection issue, we also conducted a robustness check using the Entropy Balance Method. Prior studies have highlighted the limitations of the Propensity Score Matching (PSM) method. Hainmueller (2012) and McMullin and Schonberger (2020) suggest that the Entropy Balance Method reduces coefficient bias in PSM and linear regression models. Table 3, Panel B, presents the results of the Entropy Balance Method, indicating that our findings are robust. Additionally, we also performed various PSM approaches, with the results available in Online Appendix Table A4.

4.2.2. Instrumental variable analysis

To address potential endogeneity concerns in our study, we employ an instrumental variable (IV) approach using the Two-Stage Least Squares (2SLS) model, while selecting the Google Biodiversity Attention Index as the instrument based on the approach employed by Bach et al. (2024). Specifically, we use the Google Biodiversity Attention Index (Giglio et al., 2023) as an instrument for firm-level biodiversity risk. This index measures the volume of Google searches for biodiversity-related terms such as "species loss," "ecosystem services," and "biodiversity loss" during a given period, thus capturing societal attention to biodiversity. The validity of this instrument is based on its demonstrated strong correlation with firm-level biodiversity risk, highlighting its relevance for this analysis. The Google Biodiversity Attention Index captures societal attention toward biodiversity, which aligns closely with changes in biodiversity risk at the firm level, thus establishing a meaningful relationship. Furthermore, this index is inherently exogenous to the firm's financial outcomes, as it reflects societal awareness rather than any direct impact on managerial decisions or opportunistic behaviors. This ensures both the relevance and exogeneity of the instrument, fulfilling the conditions for an appropriate instrumental variable.

Table 4 reports the results from the IV-2SLS regressions. The first-stage regression uses the Google Biodiversity Attention Index (*Attention*) as the instrument, demonstrating a statistically significant positive association with biodiversity risk. In the second stage, the coefficients of *bdr1* (*bdr2*) are significant and negative, indicating that the initial findings are robust to addressing endogeneity. The Kleibergen-Paap rk LM statistics of 56.27 (56.30) confirm that our model passes the under-identification test, indicating that the instruments are relevant. Furthermore, the Kleibergen-Paap rk Wald F-statistics of 97.66 (94.42) are well above the critical threshold of 16.38 at the 10 % significance level, confirming that weak instrument concerns are not an issue in this analysis. These results support our hypothesis that biodiversity risk significantly impacts executives' opportunistic behaviors, and the findings are consistent across both biodiversity risk proxies, thereby confirming our hypothesis.

4.2.3. Assessing biodiversity risk under climate influences

Climate and biodiversity risk are related but distinct concepts (Giglio et al., 2023). Climate risks may influence the relationship between biodiversity risk and executive opportunistic stock selling, potentially complicating the interpretation of results. These risks can add a layer of uncertainty to the operational environment, affecting both the financial performance of firms and executive decision-making regarding stock sales. To address this, we include climate risk controls in our baseline regression. Specifically, we

Table 4
IV-2SLS regression.

	(1)	(2)	(3)	(4)
	first	second	first	second
VARIABLES	bdr1	Sell	bdr2	Sell
Attention	0.015***		0.013***	
	(9.88)		(0.001)	
bdr1		−4.382***		
		(−2.82)		
bdr2				−4.902***
				(1.745)
Observations	22,084	22,084	22,084	22,084
R-squared		0.044		0.042
Cluster Industry and Year	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Industry FE	Yes	Yes	Yes	Yes
Kleibergen-Paap rk LM	56.27***		54.30***	
Kleibergen-Paap Wald rk F	97.66		94.42	
	[16.38]		[16.38]	

This table presents the results of the instrumental variable (IV) analysis using the Google Biodiversity Attention Index as an instrument for biodiversity risk. The Kleibergen-Paap rk LM and Wald F statistics confirm that the model passes the under-identification test and does not face weak instrument issues. Robust standard errors clustered at the industry and year are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

construct two climate risk variables following the approach by Pan et al. (2023), which measures extreme climate conditions. The variables are "Extreme Low Temperature" (*Ltd*) and "Extreme High Temperature" (*Htd*). These variables are included as additional controls to account for potential confounding effects from extreme climate events on the opportunistic stock selling behaviors of executives.

The results of the regression incorporating climate risk controls are presented in Table 5. The coefficients for *bdr1* and *bdr2* remain statistically significant and negative at the 5 % significance level, indicating that the inclusion of climate risk variables does not alter our primary findings. These findings suggest that biodiversity risk consistently reduces executive opportunistic selling, even after accounting for potential climate influences. The robustness of these results is supported by the stability of the negative coefficients for *bdr1* and *bdr2*.

4.2.4. Other robustness tests

To further ensure the validity of our findings, we conducted several additional robustness checks to address concerns related to the reliability of our estimates and external influences.

First, we performed a placebo test by randomly reassigning the treatment variables (bdr1 and bdr2) over 500 iterations to determine if the observed relationships were coincidental. The results, presented in Appendix Figs. A1–A4, confirm that the relationships between biodiversity risk and executive stock-selling behaviors are unlikely to be random.

Second, to account for disclosure quality concerns, we excluded firms with low-quality disclosures, retaining only those rated as "Good" or "Excellent." The results, reported in Appendix Table A5, demonstrate that our findings remain robust after excluding lower-quality disclosures.

Third, we replaced the dependent variables to examine whether the effects of biodiversity risk extend beyond opportunistic selling to general executive selling behaviors. Specifically, we substituted the opportunistic stock selling amount and frequency with total stock selling amount and frequency, as well as regular stock selling amount and frequency. The results, presented in Appendix Table A6, indicate that biodiversity risk specifically affects opportunistic selling rather than general or regular selling behavior.

Fourth, considering the censored nature of the dependent variables, we employed a Tobit regression model to ensure our estimates account for distribution limits. The results, shown in Appendix Table A7, further support the robustness of our conclusions.

Finally, we addressed regulatory impact concerns by excluding the period following the January 9, 2016, China Securities Regulatory Commission policy change, which imposed stricter regulations on insider trading and stock reduction. Following Luo and Huang (2020), we excluded samples from 2016 and 2017, with results in Appendix Table A8 showing that our initial findings remain consistent, suggesting that biodiversity risk effects are not driven by regulatory changes.

4.3. Mechanism analysis

4.3.1. Mechanism analysis of firm value

In this section, we delve into the mechanism analysis, specifically investigating whether biodiversity risk impacts executive opportunistic stock selling through its effect on firm value. The theoretical foundation has suggested that biodiversity risk can lower firm value, which in turn may reduce the incentive for executives to engage in opportunistic stock selling behavior (Ma et al., 2024).

To empirically examine this mechanism, we employ *Tobin's Q* as a measure of firm value, following Cosma et al. (2024) and Ma et al. (2024). The regression results are presented in Table 6. Columns (1) and (2) show that the coefficients for *bdr1* and *bdr2* on *Tobin's Q* are significantly negative, indicating that higher biodiversity risk leads to a reduction in firm value. In columns (3) and (4), *Tobin's Q* is used to examine its relationship with *Sell* and *SellTimes*. The positive and significant coefficients of *Tobin's Q* suggest that lower firm

Table 5
Regression results with climate risk controls.

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1	−0.248**	−0.032**		
	(0.097)	(0.012)		
bdr2			−0.304**	−0.034**
			(0.135)	(0.015)
Ltd	0.010*	0.001*	0.010*	0.001*
	(0.006)	(0.001)	(0.006)	(0.001)
Htd	−0.003	−0.001	−0.003	−0.001
	(0.004)	(0.000)	(0.004)	(0.000)
Observations	20,169	20,169	20,169	20,169
R-squared	0.166	0.149	0.166	0.149
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

This table presents the results of the regression analysis with additional controls for climate risk factors, specifically "Extreme Low Temperature" (Ltd) and "Extreme High Temperature" (Htd). Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

value curtails opportunistic selling by executives. These findings indicate that biodiversity risk reduces firm value, which subsequently discourages opportunistic stock selling by executives, providing evidence of the value-mediated pathway of biodiversity risk and supporting Hypothesis 2.

4.3.2. Mechanism analysis of long-term institutional investors divestment

For the second mechanism analysis, this section delves into the impact of divestment by long-term institutional investors on executive opportunism. The theoretical framework suggests that the withdrawal of long-term institutional investors can act as a powerful negative market signal, subsequently discouraging opportunistic stock selling by executives. To empirically explore this mechanism, we refer to Liu and Xu (2012), who classified institutional investors into long-term and short-term categories, and constructed measures for holdings by these two groups accordingly.

Moreover, given that annual reports are typically released in the following year, there is an inherent time lag in obtaining complete disclosure information. Therefore, we lagged the institutional investor variables by one period to more accurately reflect the timeline of decision-making processes. This lagging not only aligns the data with the actual timeline of information availability but also mitigates the potential endogeneity problem that might arise from using contemporaneous variables. Additionally, in this mechanism analysis regressions, the institutional investor shareholding proportions were removed from the set of control variables.

In Table 7, we examine the influence of institutional investor types on executive opportunism. *Long_shares* represents the holdings of long-term institutional investors, while *Short_shares* represents those of short-term institutional investors. Columns (1) and (2) show negative coefficients for bdr1 and bdr2 on *Long_shares*, indicating that increased biodiversity risk leads to reduced long-term institutional holdings. In columns (3) and (4), the positive coefficients for *Long_shares* on *Sell* and *SellTimes* suggest that the reduction in long-term institutional holdings effectively curbs opportunistic executive selling, providing evidence to support Hypothesis 3. In contrast, the coefficients for *Short_shares* in columns (5) to (8) are statistically insignificant, implying that divestment by short-term institutional investors has no significant impact on executive selling behavior.

4.4. Heterogeneity analysis

Corporate decision-making does not occur in isolation—firms are embedded in a broader institutional environment where external pressures play a crucial role in shaping executive behavior. When facing biodiversity risks, executives may adjust their opportunistic stock-selling behavior depending on the degree of external oversight and accountability imposed by key stakeholders. Strong external pressures can act as deterrents, making it more difficult for executives to exploit information asymmetries for personal gain.

Institutional investor site visits enhance external monitoring by reducing information asymmetry and strengthening corporate governance oversight (Cao et al., 2025). These visits also influence firms' responses to sustainability-related risks (Jiang et al., 2022). Given this role, we examine whether institutional investor site visits intensify the disciplinary effect of biodiversity risk on executive opportunistic stock selling. Panel A of Table 8 presents the results. *Site_visits* is a dummy variable that equals 1 if the number of institutional investor site visits to a firm in a given year is above the industry median and 0 otherwise. The interaction terms are both negative and statistically significant, indicating that when institutional investors conduct more site visits, the inhibitory effect of biodiversity risk on executive opportunistic stock selling is stronger.

Next, we examine the heterogeneity in the impact of biodiversity risk across regions with varying levels of environmental regulation. Stronger environmental regulation may amplify the effect of biodiversity risk by imposing stricter compliance requirements and increasing market pressure, potentially leading to declines in firm value and prompting long-term institutional investors to adjust their holdings. We hypothesize that in areas with stronger environmental regulations, the disciplinary effect of biodiversity risk on executive

Table 6
Mechanism analysis of firm value.

	(1)	(2)	(3)	(4)
VARIABLES	TobinQ	TobinQ	Sell	SellTimes
bdr1	−0.060**			
	(0.030)			
bdr2		−0.094***		
		(0.029)		
TobinQ			0.227***	0.028***
			(0.050)	(0.007)
Observations	22,084	22,084	22,084	22,084
R-squared	0.302	0.302	0.163	0.147
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

This table presents the mechanism analysis linking biodiversity risk to executive opportunistic stock selling via firm value. Columns (1) and (2) report the regression results of bdr1 and bdr2 on Tobin's Q, showing significantly negative coefficients that imply increased biodiversity risk diminishes firm value. Columns (3) and (4) show the regressions of Tobin's Q on Sell and SellTimes, indicating that lower firm value is associated with reduced opportunistic stock selling by executives. Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

Table 7
Mechanism analysis of long-term institutional investors divestment.

Panel A. Long-term institutional investors

	Long-term institutional investors			
	(1)	(2)	(3)	(4)
VARIABLES	Long_shares	Long_shares	Sell	SellTimes
bdr1	−0.223**			
	(0.104)			
bdr2		−0.186*		
		(0.107)		
Long_shares			0.052***	0.006***
			(0.016)	(0.002)
Observations	15,612	15,612	15,612	15,612
R-squared	0.395	0.395	0.162	0.147
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Panel B. Short-term institutional investors

	(1)	(2)	(3)	(4)
VARIABLES	Short_shares	Short_shares	Sell	SellTimes
bdr1	−0.102			
	(0.109)			
bdr2		−0.041		
		(0.107)		
Short_shares			0.002	0.000
			(0.013)	(0.001)
Observations	15,612	15,612	15,612	15,612
R-squared	0.239	0.239	0.161	0.146
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

This table presents the results of the mechanism analysis related to long-term institutional investor divestment and its effect on executive stock-selling behaviors. Institutional investor variables are lagged by one year to account for the delayed availability of annual report information and to mitigate potential simultaneity biases. Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

opportunistic selling will be more pronounced. To conduct this analysis, we follow the methodology of Chen and Chen (2018), using the frequency of environmental terms in local government work reports to measure the intensity of environmental regulation. The results, presented in Table 8, Panel B, confirm our hypothesis. *EnvReg* is defined as a dummy variable that equals 1 if a company's city has an environmental regulation intensity above the annual median and 0 otherwise. The negative and significant interaction terms indicate that in regions with stronger environmental regulations, biodiversity risk has a stronger inhibitory effect on executive opportunistic selling.

Finally, we explore the role of media attention in moderating the impact of biodiversity risk on executive opportunistic stock selling. Higher media attention increases the external pressure on firms, as heightened visibility and public scrutiny can lead to stronger accountability, which may amplify the inhibitory effect of biodiversity risk on opportunistic behavior. However, media coverage also plays a crucial role in reducing information asymmetry between firms and investors. When media attention is low, companies with biodiversity risks may face greater investor uncertainty due to insufficient information. This lack of coverage can result in a situation where investors perceive biodiversity risks more negatively, potentially triggering stronger market reactions, such as institutional divestment and increased stock volatility. These market pressures, in turn, may reduce executives' ability to engage in opportunistic stock selling behaviors. In the Panel C of Table 8, *Media* is defined as a dummy variable that equals 1 if the frequency of a firm's appearance in newspaper headlines is above the annual industry median and 0 otherwise. The interaction terms are both positive and statistically significant. This suggests that lower media attention actually strengthens the inhibitory effect of biodiversity risk on executive opportunism. In other words, when media coverage is lower, the lack of external scrutiny can increase the negative impact of biodiversity risk, leading to stronger market reactions, such as institutional divestment and stock volatility, which in turn discourage executives from engaging in opportunistic stock-selling behaviors.

Notably, in all three heterogeneity analyses, the coefficient for biodiversity regulation risk (*bdr2*) is consistently larger than that for biodiversity risk (*bdr1*), suggesting that biodiversity regulation risk exerts a stronger influence on executive behavior. This finding aligns with prior research highlighting that biodiversity transition risks—arising from regulatory and policy changes—pose more immediate financial challenges than physical biodiversity risks (Giglio et al., 2023). Unlike physical biodiversity risks, which materialize gradually over time, regulatory risks can lead to sudden shifts in compliance costs, legal liabilities, and market expectations,

Table 8
Heterogeneity analysis.

Panel A. Institutional investors site vists

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1 × Site_vists	−0.777***	−0.065***		
	(0.206)	(0.022)		
bdr2 × Site_vists			−0.852***	−0.085***
			(0.226)	(0.024)
Observations	19,068	19,068	19,068	19,068
R-squared	0.167	0.149	0.167	0.149
Other terms of interaction term	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Panel B. Environmental regulation

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1 × EnvReg	−0.513*	−0.068**		
	(0.283)	(0.029)		
bdr2 × EnvReg			−0.603**	−0.082**
			(0.290)	(0.033)
Observations	19,748	19,748	19,748	19,748
R-squared	0.163	0.146	0.163	0.146
Other terms of interaction term	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Panel C. media attention

	(1)	(2)	(3)	(4)
VARIABLES	Sell	SellTimes	Sell	SellTimes
bdr1 × Media	0.607***	0.058***		
	(0.166)	(0.021)		
bdr2 × Media			0.733***	0.065**
			(0.216)	(0.026)
Observations	21,733	21,733	21,733	21,733
R-squared	0.163	0.146	0.163	0.146
Other terms of interaction term	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Table 8 presents the heterogeneity analysis results. Panel A examines the role of institutional investor site visits, where *Site_visits* is a dummy variable equal to 1 if a firm's site visits exceed the industry median for the year. Panel B investigates the impact of environmental regulation, where *EnvReg* is a dummy variable equal to 1 if the firm's city has an environmental regulation intensity above the annual median. Panel C explores the role of media attention, where *Media* is a dummy variable equal to 1 if the frequency of a firm's appearance in newspaper headlines exceeds the industry median for the year. Robust standard errors clustered at the industry level are reported in parentheses. Significance levels are denoted by *, **, and *** for 10 %, 5 %, and 1 %, respectively.

creating stronger incentives for firms to respond proactively (Garel et al., 2024). As a result, regulatory pressures associated with biodiversity risk play a more significant role in shaping executive decision-making, particularly in curbing opportunistic stock-selling behaviors.

5. Conclusion

Using data from Chinese A-share listed companies from 2010 to 2022, this study used regression analyses to examine how biodiversity risk affects executive opportunistic stock selling. We find that biodiversity risk significantly suppresses executive

opportunistic stock selling, with biodiversity regulation risk having an even greater impact than general biodiversity risk. Specifically, we identified two key mechanisms: first, increased biodiversity risk leads to a decline in firm value, which subsequently curtails opportunistic selling by executives; second, divestment by long-term institutional investors triggered by heightened biodiversity risk serves as a powerful market signal, further discouraging such behaviors. Additionally, our heterogeneity analyses show that the effects of biodiversity risk are more pronounced in firms with more institutional investor site visits, stricter environmental regulations and lower media attention, further highlighting that biodiversity regulation risk exerts a greater influence on executive behavior. These insights underscore biodiversity risk, particularly its regulatory aspect, as a crucial yet underappreciated driver of executive decision-making in corporate governance.

The implications of our research are multi-faceted. For policymakers, the findings suggest that stricter environmental regulation can amplify the beneficial impact of biodiversity risk by curbing opportunistic executive behaviors. For investors, especially those with a long-term focus, this study highlights the importance of monitoring corporate responses to biodiversity risks, as such environmental factors can influence managerial behavior and firm stability. Finally, for corporate boards and governance experts, the study underscores the need to integrate biodiversity considerations into risk management practices, as doing so can mitigate not only environmental impacts but also align executive incentives with long-term sustainability goals.

CRediT authorship contribution statement

Jiangze Du: Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Fule Liu:** Writing – original draft, Software, Formal analysis, Data curation, Writing – review & editing. **Yuan-Teng Hsu:** Writing – review & editing, Supervision, Conceptualization, Formal analysis, Validation, Writing – original draft. **Dien Giau Bui:** Validation, Writing – review & editing.

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Appendix A. Supplementary data

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