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Pressure-Driven Cash Holdings Under Biodiversity Risk

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ABSTRACT

This study examines how biodiversity risk affects corporate cash holdings and the mechanisms shaping this relationship. We find that firms facing higher biodiversity risk significantly increase cash reserves. Internal CSR governance and external institutional pressures both reinforce precautionary cash policies, highlighting the importance of internal capabilities and external pressures. The increase in cash is sourced primarily from reductions in discretionary spending rather than external financing. Higher cash reserves mitigate the adverse effects of biodiversity risk, helping firms preserve financial performance, mitigate uncertainty, and maintain ESG commitments. Overall, our results underscore the precautionary nature of corporate cash management under biodiversity pressures.

JEL Classification: G30, G32, Q57

1 | Introduction

The ecological environment is fundamental to economic activity, with the World Economic Forum (WEF) reporting that more than half of global GDP depends on natural capital and ecosystem services (WEF 2020). However, as ecosystems become increasingly fragile, biodiversity loss has emerged as a material source of business risk, disrupting operations, raising compliance costs, and attracting investor scrutiny. For example, California's dramatic 62% decline in bee populations has resulted in an estimated $428 million loss in pollination contracts (Ellis and Fellow 2025). Although biodiversity risk is often broadly categorized as an environmental risk, it represents a distinct and relatively new form of risk. Unlike climate risk, which primarily reflects long-term shifts in temperature patterns, increasing extreme weather events, and regulatory uncertainty associated with climate mitigation policies, biodiversity risk arises from ecosystem degradation and the loss of species diversity that directly support economic production, affecting firms through more localized and operational channels by constraining access to essential inputs such as natural resources, biological services, and supply chains. While climate and biodiversity risks are closely interconnected, treating them equivalent can obscure the distinct mechanisms through which biodiversity loss influences firm behaviour. In particular, biodiversity degradation can undermine firms' operational resilience and financial stability even in the absence of acute climate shocks, especially for environmentally intensive or resource-dependent firms (Daily 1997; Chichilnisky and Heal 1998; Dasgupta et al. 2013). Despite its growing materiality, it remains unclear whether firms recognize biodiversity risk as a separate source of uncertainty and adjust their financial policies accordingly.

Cash holdings are central to corporate financial decision, providing flexibility and protection against liquidity shocks (Han and Qiu 2007; Bates et al. 2009; David McLean 2011; Bates et al. 2018; Cunha and Pollet 2020; Garg 2020). Prior empirical evidence documents that companies tend to increase cash holdings as a strategic response to heightened risks including natural disasters (Dessaint and Matray 2017), policy uncertainty (Duong et al. 2020), and climate-related threats (Javadi et al. 2023; Gounopoulos and Zhang 2024), highlighting the precautionary motives underlying corporate cash holdings.

However, little is known about how biodiversity loss, a growing source of uncertainty, shapes firms' liquidity strategies. The lack of empirical evidence on whether and how companies adjust cash holdings to mitigate biodiversity-related risks, the mechanisms through which such adjustments occur, and the potential consequences for the firm motivate our investigation into this underexplored relationship (Karolyi and Tobin-de la Puente 2023; Bach et al. 2025).

Keynes (1937) highlights the precautionary motive, suggesting that firms adjust liquidity strategies when facing heightened uncertainty. We extend this logic by arguing that biodiversity risk represents a distinct source of external uncertainty that exposes firms to material financial and operational pressures (Garel et al. 2024; Giglio et al. 2025). Accordingly, we hypothesize that firms confronted with greater biodiversity risk increase cash holdings as precautionary savings.

To empirically investigate the above hypothesis, we utilize firm-level biodiversity risk data from Giglio et al. (2025), which is based on a textual analysis of firms' 10-K statements. Using a comprehensive sample of US publicly listed companies spanning from 2000 to 2023, we find that firms facing higher biodiversity risk tend to hold more cash, supporting the precautionary motive for liquidity management. To address potential endogeneity concerns, we employ propensity score matching (PSM), entropy balancing, and a difference-in-differences approach using the 2021 Kunming Declaration as an exogenous shock. Our results remain consistent across different sets of robustness check.

More importantly, we investigate the mechanisms through which firms respond to biodiversity risk by holding more cash, focusing on internal corporate social responsibility (CSR) governance and external pressures. From a resource-based view (RBV) (Barney 1991), biodiversity can be regarded as a strategic asset that warrants targeted managerial attention and the development of complementary organizational capabilities (Aggarwal and Dow 2012). Our evidence indicates that the increase in precautionary cash holdings in response to biodiversity risk is concentrated among firms that have established such governance mechanisms, suggesting that CSR governance strengthens firms' financial flexibility to hedge against ecological disruptions. In addition to internal capabilities, external institutional pressures also shape how firms translate biodiversity risk into financial policy by prompting actions designed to preserve legitimacy and reinforce their image among key stakeholders (Hyatt and Berente 2017). Drawing on institutional theory, which emphasizes that firms' behaviour is shaped by coercive, mimetic, and normative pressures embedded in their institutional environments (DiMaggio and Powell 1983), we find that the positive association between biodiversity risk and cash holdings is concentrated among firms with greater exposure to government agencies and stronger industry-level CSR pressure.

Equally important to understanding firms' precautionary cash policies is uncovering the sources of such accumulations. Our results suggest that firms facing biodiversity risk do not rely on external financing to boost liquidity. Instead, they accumulate cash by reducing expenditures on research and development (R&D) and capital investment. These findings imply that biodiversity risk affects corporate financial strategies primarily through adjustments in discretionary spending rather than changes in capital structure. Furthermore, we examine whether such cash reserves serve a strategic function in insulating against the adverse consequences of biodiversity risk. Our analysis reveals that more cash holdings help mitigate the adverse effects of biodiversity risk on firms' financial performance and volatility, as well as on their sustainability outcomes and ESG reputation. Finally, we show that firms' cash-holding responses to biodiversity risk exhibit pronounced cross-sectional heterogeneity, with precautionary cash accumulation being stronger among firms facing greater environmental exposure, regulatory pressure, operational dependence on natural resources, and tighter liquidity conditions.

Our study is closely related to Ahmad and Karpuz (2024), who examine firms' liquidity responses to biodiversity risk, and extends their analysis in several important dimensions. First, we move beyond documenting the average effect by highlighting the mechanisms through which biodiversity risk influences corporate liquidity decisions, showing that both internal CSR governance and external institutional pressures from governments and industry peers heighten firms' biodiversity awareness and reinforce precautionary cash accumulation. Second, we provide new evidence on how firms build liquidity under biodiversity risk, demonstrating that cash increases are primarily achieved through internal adjustments, such as cuts in discretionary spending on R&D and capital investment, rather than through external financing. This pattern is consistent with biodiversity risk tightening financial constraints and limiting access to capital markets. Third, we highlight the economic role of precautionary cash holdings in mitigating biodiversity-related uncertainty, with higher liquidity supporting firms' financial and ESG performance. Taken together, our findings complement and extend existing evidence by offering a more integrated perspective on the mechanisms, sources, and consequences of biodiversity-driven cash-holding behaviour.

Our study contributes to the existing literature in several principal respects. First, although prior research has extensively examined the effects of climate risk on various aspects of economic activity, such as the cost of capital and investment efficiency (Agoraki et al. 2024), bankruptcy risk (Feng et al. 2024), and cash holdings (Javadi et al. 2023), current focus on climate risk represents only one dimension of environmental uncertainty. Biodiversity risk, arising from ecosystem degradation and the loss of species diversity, can weaken firms' efficiency and financial stability (Daily 1997; Chichilnisky and Heal 1998; Daily et al. 2000; Heal 2000; Ekins et al. 2003; Dietz and Neumayer 2007; Dasgupta et al. 2013), yet this important and distinct dimension has so far attracted relatively little attention (Giglio et al. 2025). Recent studies increasingly recognize biodiversity risk as a salient external risk that firms must actively manage. Bach et al. (2025) suggest that biodiversity risk weakens corporate profitability and growth outcomes, in part because heightened ecological pressures translate into higher production costs, thereby eroding firm performance. From a strategic perspective, Fu et al. (2025) further show that biodiversity risk meaningfully influences firms' supply chain decisions, prompting adjustments in the degree of supply chain concentration or diversification across different institutional and geographic environments. Our study contributes to the growing literature on biodiversity risk by deepening the

understanding of how firms' internal CSR governance mechanisms, together with external institutional pressures from government authorities and industry peers, shape corporate awareness of biodiversity-related responsibilities, and ultimately lead firms to adopt higher levels of cash holdings.

Moreover, our research contributes to the finance literature by deepening the understanding of corporate liquidity strategies, particularly the determinants of cash holdings. Empirical studies at the firm level have identified several key factors influencing cash management strategies, including corporate governance quality, managerial ownership, growth prospects, access to external financing, and CSR performance (Opler 1999; Ozkan and Ozkan 2004; Dittmar and Mahrt-Smith 2007; Denis and Sibilkov 2010; Cheung 2016). We extend this line of research by proving evidence that firms tend to increase their cash reserves to hedge against the potential adverse effects associated with rising biodiversity risk, confirming its role as an additional determinant of precautionary cash holdings. Our analysis also indicates that CSR governance, together with government and peer pressure, heightens firms' awareness of biodiversity risk and promotes greater cash retention. Taken together, these findings offer deeper insights into the ways in which biodiversity risk influences corporate cash policies and the strategic sources of liquidity in an increasingly uncertain environment.

Additionally, these findings have important implications for managers, investors, and policymakers. For investors and managers, enhancing biodiversity-related ESG reporting and strengthening CSR governance frameworks can improve transparency and help firms mitigate and manage environmental risk exposure. For policymakers, the results highlight the importance of integrating biodiversity risk into environmental regulation, financial oversight, and corporate disclosure requirements. By aligning regulatory pressure with governance incentives, policies can encourage proactive biodiversity risk management while supporting firms' financial stability and sustainable growth.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and develops our hypotheses. Section 3 describes the research design. Section 4 reports the empirical results and investigates the mechanisms. Section 5 presents robustness checks. Section 6 concludes the study.

2 | Literature Review and Hypotheses Development

2.1 | Biodiversity Risk and Corporate Cash Holdings

Biodiversity risk refers to the physical and regulatory threats arising from biodiversity loss and their economic and valuation consequences (Giglio et al. 2025). Driven by ecosystem degradation and declining species diversity, biodiversity loss can disrupt firms' access to natural resources, affect labour and capital markets, and increase regulatory compliance costs, thereby undermining operational efficiency and financial stability (Daily 1997; Chichilnisky and Heal 1998; Daily et al. 2000; Heal 2000; Ekins et al. 2003; Dietz and Neumayer 2007; Dasgupta et al. 2013).

Biodiversity risk is a material factor in firm performance and financial decision-making, affecting both corporate outcomes and investor behaviour. Prior studies show that biodiversity risk negatively impacts firm performance (Bach et al. 2025) and influences stock performance, as firms with stronger biodiversity strategies exhibit lower stock-price crash risk (Bassen et al. 2024). Investor responses further underscore its financial relevance: while biodiversity footprint did not explain cross-sectional returns before 2021, a biodiversity risk premium emerged after the Kunming Declaration, reflecting concerns over regulation, litigation, and cash flow uncertainty (Garel et al. 2024; Coqueret et al. 2025). Overall, this evidence indicates that biodiversity risk shapes corporate performance, investor sentiment, and market pricing.

Addressing the growing challenges posed by biodiversity risk has become increasingly important, and increasing cash holdings represents one of the key strategies available to firms. Maintaining higher levels of cash enables firms to cope with economic uncertainty, pursue investment opportunities, and meet unforeseen financial demands. Empirical research has highlighted several factors, including corporate governance, managerial ownership, growth opportunities, external risk, access to external financing, and CSR performance as critical influences on cash management strategies (Opler 1999; Ozkan and Ozkan 2004; Dittmar and Mahrt-Smith 2007; Denis and Sibilkov 2010; Cheung 2016; Phan et al. 2019). More recently, an expanding body of literature has emphasized the impact of environmental risks, particularly climate risk, on corporate cash-holding decisions (Javadi et al. 2023; Gounopoulos and Zhang 2024; Zhang et al. 2024; Fernandes and Papadimitriou 2025).

While climate risk is a crucial aspect of the relationship between economic activity and environmental sustainability, it represents only one dimension of this interaction (Giglio et al. 2025). Biodiversity risk constitutes another critical and distinct dimension, involving threats to ecosystems and species diversity that can generate significant financial and operational risks for firms. Although conceptually different, climate and biodiversity risks are inherently interconnected and may reinforce or amplify one another (Flammer et al. 2025; Giglio et al. 2025). Firms in environmentally intensive industries therefore face increasing regulatory scrutiny, investor pressure, and reputational risks related to both concerns, making biodiversity risk management an important component of broader climate risk mitigation strategies (Karolyi and Tobin-de la Puente 2023).

A well-substantiated explanation for rising corporate cash holdings is the precautionary motive, which suggests that firms hold cash to protect against unforeseen financial shocks and liquidity needs (Keynes 1937). Higher cash reserves enhance financial flexibility and serve as a hedge against unexpected expenditures (Han and Qiu 2007; Bates et al. 2009; David McLean 2011; Bates et al. 2018; Cunha and Pollet 2020; Garg 2020). Empirical evidence shows that firms increase cash holdings in response to heightened risk, such as natural disasters (Dessaint and Matray 2017) and policy uncertainty (Duong et al. 2020). In the context of biodiversity risk, firms face increased financial uncertainty arising from both physical risks linked to ecosystem degradation and transition risks related to regulation, market responses, and investor scrutiny (Garel et al. 2024; Giglio et al. 2025). As a result, firms exposed to greater biodiversity risk are likely to adjust their liquidity management policies to mitigate potential financial uncertainty.

According to stakeholder theory (Freeman 2010), firms operate within a broader ecosystem of stakeholders, whose diverse interests must be considered alongside those of shareholders. Environmental responsibility, particularly biodiversity protection, has therefore become an increasing stakeholder concern. Governments and international organizations are tightening regulations on biodiversity-harming activities, raising compliance costs and legal risks, while growing investor emphasis on ESG factors may restrict access to capital for firms with high biodiversity risk (Baker et al. 2022). ESG-oriented investors and financial institutions are less willing to finance environmentally harmful firms (Boyer and Laffont 1997), leading to higher borrowing costs and constrained funding, which can undermine revenue stability. In response, firms may maintain cash reserves to facilitate stakeholder engagement, invest in sustainable operations, and mitigate the risks associated with litigation.

Drawing on the precautionary motives for cash holdings and insights from stakeholder theory, firms exposed to biodiversity risk are likely to increase their cash reserves to manage heightened financial uncertainty and regulatory complexity. In the context of tightening environmental regulations and growing stakeholder expectations around sustainability, maintaining liquidity becomes essential for firms to absorb potential financial shocks and ensure operational continuity. Therefore, we propose our first hypothesis:

H1. *Firms with biodiversity risk tend to have higher cash holdings.*

2.2 | Internal Governance and External Pressures Channels

Although biodiversity risk generally increases firms' demand for precautionary cash holdings, the magnitude of this effect likely depends on how firms perceive and respond to such risks. These responses can be broadly categorized into internal governance and external pressures. Internal governance reflects the extent to which sustainability considerations are embedded in organizational structures and incentives, while external pressures arise from regulatory oversight and competitive dynamics. Distinguishing between these mechanisms helps clarify how biodiversity risk is translated into financial policy decisions.

The RBV posits that sustainable competitive advantage stems from valuable, rare, inimitable, and non-substitutable resources (Barney 1991). Building on this view, the Natural RBV emphasizes the strategic role of aligning internal capabilities with environmental challenges (Hart 1995). Within this framework, biodiversity can be viewed as a form of natural capital and a strategic asset, particularly for firms reliant on ecosystem services. Such firms may hold higher cash reserves to hedge against ecological disruptions and to finance biodiversity conservation, sustainable sourcing, and ecological restoration. Managing biodiversity risk often requires substantial expenditures on sustainability programs, compliance, and operational adjustments, which can strain short-term liquidity (Bassen et al. 2024).

A firm's ability to internalize and respond to biodiversity risk depends critically on its governance structures. Prior work suggests that environmental and climate-related decisions are shaped by the nature of corporate governance (Aggarwal and Dow 2012). CSR-related governance mechanisms, such as dedicated sustainability committees, external reporting practices, and CSR-linked executive incentives, reflect the distribution of rights and responsibilities within firms regarding sustainability (Aguilera et al. 2021). These mechanisms operate as organizational resources that enhance managerial awareness and accountability for sustainability considerations. By integrating biodiversity concerns into decision-making, these mechanisms enable firms to anticipate ecological risks and are likely to strengthen precautionary cash-holding policies. Accordingly, the positive relationship between biodiversity risk and cash holdings should be stronger among firms with stronger CSR governance.

While internal CSR governance enables firms to recognize and address biodiversity risks, external pressures are also crucial in shaping sustainability commitments. Firms adjust their behaviour not only for internal accountability but also to maintain legitimacy with external stakeholders (Hyatt and Berente 2017), and internal and external forces are complementary in explaining corporate social performance (Menguc et al. 2010). Institutional theory highlights that firms operate within broader social and regulatory environments that impose coercive pressures from regulators, mimetic pressures from competitors, and normative pressures reflecting stakeholder expectations (DiMaggio and Powell 1983; Adebanjo et al. 2016; Hyatt and Berente 2017).

Although firms face pressures from many stakeholders, governments are often the most influential, as public policies and regulatory frameworks exert substantial and binding pressure on corporate behaviour (Chang et al. 2015; Cornell and Shapiro 2021). In the context of biodiversity risk, government regulation represents a coercive pressure. Public policies and oversight by agencies such as the Environmental Protection Agency create strong compliance demands and potential penalties that compel firms to anticipate associated costs. Beyond regulation, external pressures may also arise from market competition and industry dynamics, where firms adopt the risk management practices of peers to maintain legitimacy and avoid competitive disadvantage. Together, these institutional forces encourage precautionary financial strategies, implying that the positive relationship between biodiversity risk and cash holdings is stronger for firms facing greater external institutional pressure.

Taken together, the above arguments suggest that both firm-driven internal governance and externally imposed institutional pressures condition how biodiversity risk translates into financial policy. We therefore propose the following hypotheses:

H2a. *The positive relationship between biodiversity risk and cash holdings is more pronounced in firms with stronger CSR-related governance.*

H2b. *The positive relationship between biodiversity risk and cash holdings is more pronounced in firms subject to stronger external institutional pressures.*

3 | Research Design

Our initial sample comprises publicly listed firms in the United States, spanning the years 2000–2023. The sample period begins

in 2000 due to data availability constraints, as biodiversity risk data are only accessible from that year onward. Consistent with prior research on corporate cash holdings (e.g., Gounopoulos and Zhang 2024; Zhang et al. 2024), we exclude observations for financial firms (SIC codes 6000–6999) and utilities (SIC codes 4900–4999), as these sectors are subject to stricter regulatory oversight, possess distinct industry characteristics, and may follow different cash-holding incentives.

To examine the relationship between corporate cash holdings and biodiversity risk, we obtain a firm-level proxy for biodiversity risk from Giglio et al. (2025).[1] Specifically, Giglio et al. (2025) identify biodiversity-related content in firms' 10-K filings using a biodiversity dictionary. By applying regular expression searches, their approach filters out sentences containing unrelated terms, ensuring that only relevant biodiversity disclosures are retained. For each firm-year observation, if a 10-K filing contains at least two biodiversity-related sentences, the firm is assigned a binary score of "1" indicating the acknowledgement of biodiversity-related risks; otherwise, it receives a "0." This binary classification provides a clear and consistent signal of a firm's recognition of biodiversity risk, and it helps isolate this specific risk dimension from other financial or operational disclosures.

More importantly, drawing on established definitions in the literature regarding cash holdings (e.g., Opler 1999; Bates et al. 2009; Cheung 2016; Dudley and Zhang 2016; Hanlon et al. 2017; Gounopoulos and Zhang 2024), we construct our corporate cash holding variables as the ratio of cash and cash equivalents to book assets (*CashTA*) and the ratio of cash and cash equivalents to net assets (*CashNA*).[2] We incorporate a set of control variables commonly identified in the literature as key determinants of corporate cash holdings (e.g., Opler 1999; Dittmar et al. 2003; Bates et al. 2009; Ni 2019; Boasiako and Keefe 2021; El Kalak and Tosun 2022; Elnahas et al. 2024; Chen et al. 2025). These variables include firm size (*SIZE*), market-to-book ratio (*MB*), financial leverage (*LEV*), net working capital (*NWC*), research and development intensity (*RD*), operating cash flow (*Cashflow*), capital expenditures (*CAPX*), sales growth (*Growth*), expenditures on acquisitions (*Acquisition*), dividend-paying dummy (*Dividend Dummy*), cash flow volatility (*STD_CFO*), and selling, general, and administrative expenditures (*SGA*). A comprehensive list of variables and definitions is provided in Table A1. After applying the sample selection procedures, our final data set consists of 35,936 firm-year observations, with 4003 unique firms.[3] Table 1 presents the summary statistics of our sample.

The 0.218 average cash holdings reported in Panel A of Table 1 indicate that firms retain approximately 21.8% of their total assets in cash and cash equivalents on average, reflecting a relatively conservative liquidity reserve that is consistent with prior evidence in the corporate cash holdings literature (Subramaniam et al. 2011; Hanlon et al. 2017; Gounopoulos and Zhang 2024). As captured by the binary *BioRisk* measure, about 2.9% of observations indicate recognition of biodiversity risk in 10-K disclosures, indicating that while such risks are still recognized by a minority of firms, they are becoming a salient disclosure issue. The average firm size, as proxied by the natural logarithm of total assets, is 7.089, while the mean market-to-book ratio is 2.417. Firms spend roughly 5.1% of total assets on R&D and about 4.7% on capital expenditures, with an average sales growth rate of 18.5%. In terms of payout policy, 42.8% of firm-year observations are dividend payers. Panel B of Table 1 presents the annual distribution of biodiversity risk from 2000 to 2023, showing a clear upward trend over time. While biodiversity risk is virtually absent in the early 2000s, both the number and proportion of affected firms increase steadily, exceeding 4% in recent years, indicating that biodiversity risk has become an increasingly relevant consideration for firms.

Following prior literature (e.g., Opler 1999; Bates et al. 2009; Hanlon et al. 2017; Zhang et al. 2024), we adopt the following model to examine the impact of biodiversity risk on the corporate cash holding:

$$Cashholding_{i,t} = \alpha + \beta \times BioRisk_{i,t} + Controls_{i,t} + YearFE + FirmFE + \varepsilon_{i,t} \quad (1)$$

where i and t denote firm and year, respectively. The dependent variable, *Cashholding*, is measured using two proxies: *CashTA*, defined as the ratio of cash and cash equivalents scaled by total assets, and *CashNA*, defined as cash and cash equivalents divided by net assets. Our primary variable of interest is *BioRisk*, as defined by Giglio et al. (2025). *Controls* represents a set of control variables encompassing commonly recognized firm-level factors that influence corporate cash holdings, as outlined in the previous discussion. Furthermore, we include firm fixed effects in our analysis to control for both observable and unobservable time-invariant characteristics of each firm. We also control for year fixed effects to account for period-specific shocks and macroeconomic trends. Standard errors are adjusted for clustering at firm level. All continuous variables are winsorized at the 1st and 99th percentiles.

4 | Main Findings

4.1 | Baseline Results

Table 2 presents the results of the multivariate analysis examining the effect of biodiversity risk on cash holdings (Equation 1). The dependent variable is measured using our two proxies: *CashTA*, defined as cash and cash equivalents scaled by total assets, and *CashNA*, defined as cash and cash equivalents divided by net assets. Columns (1) and (2) include *BioRisk* as the sole explanatory variable, without any control variables. Columns (3) and (4) extend the analysis by adding a comprehensive set of firm characteristics and investment-related controls. Across all specifications, the coefficients of *BioRisk* are positive and statistically significant, confirming our *H1* that firms exposed to biodiversity risk tend to have higher cash holdings. The results are also economically significant. Based on the coefficient reported in column (3), we observe that firms facing biodiversity risk hold, on average, 9.2% more cash relative to total assets than firms not facing such risk.[4]

Regarding the control variables, our findings reveal that cash holdings are negatively correlated with firm size, leverage, and net working capital. Moreover, we find a significant positive relationship between the market-to-book ratio and cash holdings. Additionally, our multivariate analysis confirms that cash holdings are negatively related to R&D investment, capital expenditures, acquisitions, and selling, general, and administrative (SG&A) expenses. These results align with the evidence

TABLE 1 | Descriptive statistics.

Panel A

Variable	*N*	Mean	p25	Median	p75	SD
CashTA	35,936	0.218	0.044	0.131	0.324	0.228
CashNA	35,936	0.615	0.046	0.151	0.479	1.481
BioRisk	35,936	0.029	0.000	0.000	0.000	0.167
SIZE	35,936	7.089	5.842	6.969	8.192	1.702
MB	35,936	2.417	1.305	1.795	2.785	1.822
LEV	35,936	0.230	0.032	0.199	0.354	0.211
Growth	35,936	0.185	−0.001	0.088	0.223	0.495
Cashflow	35,936	0.074	0.042	0.091	0.140	0.132
Dividend Dummy	35,936	0.428	0.000	0.000	1.000	0.495
STD_CFO	35,936	0.055	0.017	0.033	0.062	0.068
RD	35,936	0.051	0.000	0.008	0.068	0.090
CAPX	35,936	0.047	0.016	0.031	0.057	0.050
NWC	35,936	0.047	−0.043	0.040	0.138	0.150
Acquisition	35,936	0.027	0.000	0.000	0.020	0.062
SGA	35,936	0.196	0.073	0.153	0.291	0.213

Panel B: Sample distribution by year

Year	*N*	BioRisk	Percentage
2000	1570	0	0.00%
2001	1359	16	1.18%
2002	1311	10	0.76%
2003	1363	24	1.76%
2004	1490	21	1.41%
2005	1483	29	1.96%
2006	1539	29	1.88%
2007	1569	30	1.91%
2008	1467	32	2.18%
2009	1349	29	2.15%
2010	1410	36	2.55%
2011	1400	39	2.79%
2012	1394	45	3.23%
2013	1469	43	2.93%
2014	1525	55	3.61%
2015	1523	57	3.74%
2016	1485	63	4.24%
2017	1480	66	4.46%
2018	1500	71	4.73%
2019	1492	67	4.49%
2020	1602	56	3.50%
2021	1841	61	3.31%
2022	1732	79	4.56%
2023	1583	74	4.67%
Total	35,936	1032	2.87%

Note: This table presents summary statistics for the sample of US public firms from 2000 to 2023. Panel A reports descriptive statistics for the main variables used in the main analysis. Panel B reports the annual distribution of firm-year observations and the incidence of biodiversity risk over time. Table A1 provides definitions of all variables. All continuous variables are winsorized at the 1% and 99% levels.

TABLE 2 | Biodiversity risk and cash holdings.

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
BioRisk	0.022*** (4.51)	0.087*** (3.24)	0.020*** (4.24)	0.080*** (2.63)
SIZE			−0.048*** (−14.03)	−0.258*** (−8.37)
MB			0.011*** (11.02)	0.055*** (6.21)
LEV			−0.125*** (−12.00)	−0.730*** (−6.99)
Growth			0.002 (1.20)	0.037 (1.20)
Cashflow			0.005 (0.33)	−0.525*** (−3.36)
Dividend Dummy			0.001 (0.40)	0.044*** (2.61)
STD_CFO			0.156*** (7.45)	1.735*** (5.97)
RD			−0.256*** (−6.80)	−2.630*** (−5.91)
CAPX			−0.399*** (−12.66)	−2.102*** (−10.70)
NWC			−0.329*** (−18.95)	−1.626*** (−12.78)
Acquisition			−0.280*** (−24.01)	−1.167*** (−16.42)
SGA			−0.203*** (−12.40)	−2.110*** (−10.51)
Constant	0.223*** (16.15)	0.945*** (7.24)	0.622*** (23.28)	3.288*** (12.31)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.819	0.733	0.856	0.767
Observations	35,936	35,936	35,936	35,936

Note: This table reports the impact of biodiversity risk on corporate cash holdings. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *** indicates significance at the 1% level.

presented in previous studies (e.g., Cheung 2016; Gounopoulos and Zhang 2024).

4.2 | Potential Mechanisms: External and Internal Pressures

In the main analysis, we find that biodiversity risk is positively associated with corporate cash holdings. We argue that this result is consistent with the precautionary motive for cash holdings, which suggests that firms accumulate liquid reserves to hedge against heightened financial uncertainty. Moreover, drawing on stakeholder theory (Freeman 2010), firms are subject to increasing demands from governments, investors, NGOs, and local communities to address biodiversity concerns, which further encourages precautionary liquidity management. From the perspective of the Natural RBV (Hart 1995), biodiversity constitutes a form of strategic natural capital, and firms that are more dependent on ecosystem services may deliberately maintain higher cash reserve to hedge against ecological disruptions. Finally, consistent with institutional theory (DiMaggio and Powell 1983), external coercive, mimetic, and normative pressures reinforce the tendency for firms facing biodiversity risk to increase cash holdings. To further investigate these mechanisms, we examine how both internal CSR governance and external pressures moderate the relationship between biodiversity risk and cash holdings.

4.2.1 | *Internal CSR Governance Pressures*

While biodiversity risk tends to strengthen firms' incentives to accumulate precautionary cash, the magnitude of this effect depends on the extent to which sustainability considerations are integrated into corporate governance. Internal institutional pressures refer to the normative and cognitive forces that originate within the organization, including managerial incentives, organizational structures, corporate culture, and internal stakeholder expectations (Zhang and Zhu 2019). In the context of biodiversity risk, these pressures embed biodiversity considerations into firms' governance and decision-making processes and capture firms' internal capacity to recognize, internalize, and respond to biodiversity-related pressures, shaping how managers perceive and respond to environmental uncertainty. By enhancing awareness, stronger CSR governance are expected to amplify the positive relationship between biodiversity risk and cash holdings.

To capture these mechanisms empirically, we follow Albitar et al. (2023) and choose CSR governance indicators obtained from the Refinitiv ESG database, which provides firm-level information on executive pay linkage to sustainability, the existence of CSR committees or teams, and CSR disclosure practices. Linking executive compensation to sustainability outcomes, which can lead to an increase in long-term orientation and environmental initiatives (Flammer et al. 2019), aligns managerial incentives with biodiversity objectives; the existence of CSR committees or dedicated teams, which can balance a firm's financial and non-financial goals (Liao et al. 2015), institutionalizes sustainability oversight and reinforces normative expectations within the organization; and CSR disclosure practices reflect the internalization of transparency norms and accountability regarding biodiversity-related impacts. Collectively, these mechanisms operationalize internal institutional

pressures that strengthen firms' precautionary responses to biodiversity risk, including higher cash holdings. Table 3 presents the moderating role of internal CSR governance.

The results in Panel A of Table 3 show that the positive association between biodiversity risk and cash holdings is more pronounced when senior executives' compensation is linked to CSR, H&S, or sustainability targets. Specifically, the coefficient of *BioRisk* is statistically significant in columns where CSR-related incentives are present, whereas the effect is insignificant when such incentives are absent. A similar situation is observed when firms adopt compensation policies tied to ESG or sustainability factors, where biodiversity risk is significantly associated with higher cash reserves. These findings suggest that including sustainability objectives into executive and management compensation strengthens managerial incentives to recognize biodiversity-related uncertainties and to respond by holding additional precautionary liquidity, reflecting the internalization of coercive and normative pressures.

Panel B further highlights the role of organizational structure. Firms with a CSR committee at the board or senior management level exhibit a significant positive relationship between biodiversity risk and cash holdings compared to firms without such structures. Likewise, companies with an environmental management team devoted to sustainability issues show a significant increase in cash holdings when facing biodiversity risks. These results, consistent with the normative pressure, imply that CSR-related organizational arrangements enhance the firm's capacity to incorporate environmental concerns, thereby maintaining greater cash reserves to address such issues.

Panel C examines the moderating role of disclosure requirements. The results consistently show that the positive association between biodiversity risk and cash holdings is stronger for firms with higher levels of CSR- and environment-related disclosure. First, when firms issue a separate CSR/H&S/Sustainability report, or include a dedicated section in their annual report, the coefficient on *BioRisk* is significantly positive, while the effect is insignificant among firms without such disclosure. Second, firms with biodiversity-related reporting are associated with a stronger positive relationship between biodiversity risk and cash holdings. Third, disclosure on environmental expenditures or investments further strengthens this relationship, since firms facing biodiversity risk tend to retain more cash when they communicate proactively about environmental risks and opportunities. Reflecting firms' response to coercive pressures, enhanced disclosure increases firms' awareness of biodiversity exposure and public scrutiny, incentivizing more conservative cash management to ensure credibility, resilience, and continuity of ESG commitments.

Therefore, these findings suggest that internal CSR governance, through compensation incentives, organizational structures, and disclosure practices, enhances firms' ability and willingness to anticipate biodiversity-related uncertainties and motivates precautionary cash accumulation. Therefore, the evidence supports H2a.

4.2.2 | *External Regulatory and Peer Pressures*

Beyond internal governance mechanisms, external institutional pressures also play an important role in shaping how biodiversity risk affects firms' financial policies. External institutional pressures refer to the coercive, normative, and mimetic forces that arise from a firm's external environment, including regulators, industry peers, investors, and other stakeholders (Scott 2013). In the context of biodiversity risk, these pressures compel firms to adapt their strategies and operations to evolving regulatory requirements, societal expectations, and market norms related to biodiversity protection to preserve organizational legitimacy and competitive positioning (Berrone et al. 2013; Dupire and M'Zali 2018).

Coercive pressures arise from environmental regulation and enforcement that directly affect firms' exposure to biodiversity-related compliance costs, while normative pressures reflect growing societal and professional expectations for biodiversity responsibilities. Mimetic pressures emerge as firms respond to uncertainty by imitating peers that are perceived as legitimate in managing biodiversity impacts. Collectively, these external institutional forces shape corporate responses to biodiversity risk by reinforcing expectations of regulatory compliance and environmental responsibility, thereby influencing firms' financial and strategic decisions, including precautionary cash management. Table 4 reports the results for two sources of external pressures: government agency exposure and peer pressure.

For firms' exposure to government agencies, we follow Armstrong et al. (2025) and use their index to measure firm-level exposure.[5] Specifically, we rely on the exposure to environmental protection agency as a proxy for biodiversity-related regulatory pressure. Firms above the annual median are classified as being under high regulatory pressure, while those below the median are considered low-pressure firms. Panel A shows that the positive relationship between biodiversity risk and cash holdings is more pronounced among firms with high exposure to government agencies. The coefficient of *BioRisk* is positive and statistically significant for firms subject to greater regulatory pressure, while the effect is insignificant for firms with low exposure. This finding indicates that government scrutiny heightens firms' awareness of biodiversity-related uncertainties and motivates them to adopt precautionary liquidity strategies. Consistent with the coercive institutional pressure, regulation and enforcement by environmental authorities expose firms to greater legal risk, higher compliance and remediation costs, and tighter operational constraints related to biodiversity protection. Firms operating under stronger regulatory scrutiny face heightened uncertainty regarding future cash outflows and regulatory compliance, which strengthens incentives to hold precautionary cash reserves.

For CSR peer pressure, we calculate the annual average CSR score of firms operating within the same two-digit SIC industry, a widely used peer classification that captures groups of similar firms (Kaustia and Rantala 2021). This classification reflects shared product markets, technologies, and competitive conditions while preserving sufficient within-industry variation, making it well suited for capturing economically meaningful peer influence. Firms above the annual median are classified as being under high CSR peer pressure, while those below the median are considered low-pressure firms. Panel B highlights the role of peer influence within industries. Firms operating in industries where peer companies exhibit higher CSR engagement display a significantly stronger association between biodiversity risk and cash holdings compared to firms in low-

TABLE 3 | Mechanism analysis: The role of corporate CSR governance.

Panel A: Compensation incentives

	CSR-linked compensation				ESG-linked pay			
	No		Yes		No		Yes	
Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
BioRisk	0.009 (1.50)	0.017 (1.00)	0.010** (2.14)	0.015* (1.70)	−0.003 (−0.51)	0.011 (0.55)	0.012*** (2.77)	0.015* (1.67)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.895	0.832	0.885	0.933	0.897	0.838	0.872	0.823
Observations	14,113	14,113	5012	5012	12,680	12,680	5875	5875

Panel B: Organizational structure

	CSR Committee				Environmental Management Team			
	No		Yes		No		Yes	
Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
BioRisk	0.007 (1.02)	−0.009 (−0.42)	0.008* (1.73)	0.023** (2.13)	−0.000 (−0.06)	−0.003 (−0.16)	0.011*** (2.71)	0.017*** (2.69)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.906	0.838	0.876	0.857	0.882	0.821	0.831	0.846
Observations	10,808	10,808	7775	7775	11,155	11,155	6100	6100

Panel C: Disclosure requirements

	Sustainability reporting				Biodiversity impact reporting				Environmental expenditures/investments			
	No		Yes		No		Yes		No		Yes	
Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(5) *CashTA*	(6) *CashNA*	(7) *CashTA*	(8) *CashNA*	(9) *CashTA*	(10) *CashNA*	(11) *CashTA*	(12) *CashNA*
BioRisk	0.007 (1.03)	0.010 (0.54)	0.010** (2.26)	0.021* (1.83)	0.008 (1.13)	0.001 (0.08)	0.009* (1.87)	0.018** (2.04)	0.008 (1.36)	0.017 (1.08)	0.010** (2.36)	0.015** (2.39)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.907	0.836	0.868	0.843	0.892	0.835	0.808	0.820	0.865	0.808	0.794	0.818
Observations	10,755	10,755	7787	7787	15,845	15,845	2593	2593	10,900	10,900	3225	3225

Note: This table examines the internal mechanism underlying the relationship between biodiversity risk and corporate cash holdings, focusing on firms' CSR governance. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. Panel A examines executive and management compensation incentives, Panel B considers organizational structure, and Panel C focuses on disclosure requirements. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 4 | Mechanism analysis: The role of external pressures.

Variables	Low		High	
	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
Panel A: Firms' exposure to government agencies				
BioRisk	0.002 (0.24)	−0.031 (−0.68)	0.015*** (3.07)	0.064* (1.69)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.855	0.750	0.833	0.800
Observations	23,858	23,858	7451	7451
Panel B: CSR peer pressure				
BioRisk	0.009	0.010	0.008**	0.019**
	(1.29)	(0.43)	(2.43)	(2.07)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.904	0.831	0.857	0.787
Observations	10,150	10,150	8976	8976

Note: This table investigates potential external mechanisms underlying the relationship between biodiversity risk and corporate cash holdings. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. Panel A splits firms according to their exposure to government agencies. Panel B splits firms according to industry average CSR score. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

pressure environments. The results indicate that peer pressure strengthens firms' incentives to hold cash in response to biodiversity-related risks. When peer firms exhibit higher CSR performance, individual firms face normative expectations to conform to sustainability standards and may imitate peers perceived as legitimate or successful in managing environmental risks. Such peer pressure heightens managerial awareness of biodiversity-related expectations and amplifies precautionary responses, including higher cash holdings, to maintain competitiveness and legitimacy within the industry.

Overall, these results suggest that both regulatory and peer-related institutional pressures reinforce firms' precautionary cash-holding motives. Firms under greater scrutiny from government agencies, as well as those facing stronger CSR peer pressure, are more likely to accumulate precautionary liquidity in response to biodiversity risk. Therefore, the evidence supports H2b.

4.3 | Source of Cash Holdings

We further examine the channel through which firms accumulate cash reserves in response to biodiversity risk. Firms could employ strategies such as obtaining external financing and adjusting their investment decisions. Panel A of Table 5 reports the results examining the effect of biodiversity risk on firms' equity and debt issuance activities. Column (1) reports the *Equity Issue*, measured as the ratio of the net difference between equity sales and repurchases to total assets. Column (2) reports the *Debt Issue*, defined as the ratio of the net difference between long-term debt issuance and long-term debt reduction to total assets. Column (3) presents the *Total Issue*, calculated as the sum of equity and debt issuance, scaled by total assets. All coefficients are insignificant. These findings suggest that biodiversity risk does not lead to an increase in external financing. Firms exposed to biodiversity risk are often subject to regulatory and reputational challenges, which can deter financing. Additionally, financial institutions and investors with sustainability objectives are less inclined to extend financing to such firms. Consequently, these companies are more likely to face financial instability, making it more difficult for them to secure external funding (Goss and Roberts 2011; Krueger et al. 2020).

In Panel B, the dependent variables are firm investments and expenses that reduce cash holdings. Column (1) reports the R&D investment (*RD*), measured as the research and development expenses divided by total assets. Column (2) reports the capital expenditure (*CAPX*), measured as the capital expenditures divided by total assets. Column (3) reports selling, general, and administrative expenses (*SGA*), measured as the selling, general, and administrative expenses divided by total assets. Our results indicate that biodiversity risk is associated with the reduction in R&D and capital expenditures, suggesting that firms facing biodiversity risk tend to increase their cash reserves by cutting expenditures on R&D and capital expenditures. This finding aligns with work suggesting that firms under pressures may prefer to tighten discretionary spending (Cohen et al. 2010). Overall, these results indicate that biodiversity risk influences corporate financial strategies through adjustments in discretionary spending rather than changes in capital structure, and a key reason is that firms facing biodiversity risks struggle to obtain external financing, which constrains their ability to alter their capital structure.

TABLE 5 | Source of cash holdings.

Variables	(1) Equity Issue	(2) Debt Issue	(3) Total Issue
Panel A: External financing			
BioRisk	0.003 (0.54)	−0.001 (−0.20)	0.002 (0.39)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj R^2	0.534	0.312	0.539
Observations	32,923	34,485	31,669
Variables	**(1) *RD***	**(2) *CAPX***	**(3) *SGA***
Panel B: Investments and expenses			
BioRisk	−0.005** (−2.24)	−0.005** (−2.21)	0.006 (1.22)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj R^2	0.865	0.703	0.900
Observations	20,462	35,936	33,269

Note: This table examines the channels through which biodiversity risk influences corporate cash holdings. Panel A focuses on external financing sources that increase cash reserves, including equity issuance, debt issuance, and total financing. Panel B examines firm investments and expenses that reduce cash reserves, including R&D expenditures (*RD*), capital expenditures (*CAPX*), and selling, general, and administrative expenses (*SGA*). *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ** denotes significance at the 5% level.

Consequently, rather than issuing new equity or increasing debt, these firms are more likely to adjust internal expenditures. Modifying discretionary spending, such as investments in R&D and capital expenditures, enables a more immediate response to financial constraints while preserving short-term financial flexibility.

4.4 | Cash Holdings in Mitigating Biodiversity Risk Impact

Having established that firms tend to accumulate cash in response to biodiversity risk, primarily by reducing discretionary expenditures, we next investigate whether these cash reserves play a strategic role in mitigating the adverse effects of such risk. Specifically, we examine the extent to which cash holdings can cushion firms from the negative consequences of biodiversity exposure.

Table 6 presents the analysis of how biodiversity risk affects future firm performance, both in financial and ESG terms, and whether this impact differs depending on firms' cash holdings. Panel A focuses on financial performance. The results indicate that biodiversity risk leads to a significant decline in return on assets and Tobin's *Q* in the following year. However, this negative relationship is not significant for firms with high cash holdings. This finding suggests that firms with substantial cash reserves are better equipped to absorb the financial impact of biodiversity-related challenges. Cash provides flexibility to manage unexpected costs, reallocate resources, or invest in risk mitigation strategies, thereby limiting the detrimental effect on profitability and market valuation. In contrast, firms with low cash holdings lack such financial reserve and are therefore more exposed to biodiversity-related shocks that can directly impair operational performance and firm value. Moreover, Tobin's *Q* captures not only current performance but also investors' expectations regarding future growth and risk management. Firms with strong cash positions are likely perceived as more resilient and better prepared to handle biodiversity risks, resulting in more optimistic valuations.

Panel B analyses the relationship between biodiversity risk and firm risk. We find that firms exposed to higher biodiversity risk exhibit greater total and idiosyncratic volatility, consistent with biodiversity loss increasing operational and financial uncertainty. Importantly, this positive association is observed only among firms with relatively low cash holdings, suggesting that insufficient liquidity amplifies the risk implications of biodiversity exposure. In contrast, firms that hold higher cash reserves are better able to absorb biodiversity-related disruptions, stabilizing operations and reducing volatility. These findings are consistent with a self-insurance role of precautionary cash holdings in mitigating biodiversity-related uncertainty.

Panel C presents the results for sustainability outcomes, as measured by ESG and Environmental Scores. We observe that biodiversity risk significantly lowers ESG performance in the subsequent period. However, this adverse effect is only statistically significant among firms with low levels of cash holdings. For firms with high cash reserves, the negative relationship between biodiversity risk and ESG outcomes is not significant, suggesting that cash holdings play a mitigating role in preserving ESG performance under environmental stress. This mitigating effect can be attributed to the financial and strategic advantages that cash reserves provide. Greater cash holdings provide firms with the financial flexibility to sustain ESG initiatives amid biodiversity-related challenges.

TABLE 6 | The mitigating role of cash holdings.

Variables	Main effect (1) *ROA*	Low (2) *ROA*	High (3) *ROA*	Main effect (4) Tobin's *Q*	Low (5) Tobin's *Q*	High (6) Tobin's *Q*
Panel A: Financial performance						
BioRisk	−0.024*** (−3.87)	−0.024*** (−3.61)	−0.017 (−1.02)	−0.067* (−1.89)	−0.066** (−2.54)	−0.021 (−0.15)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.648	0.477	0.692	0.747	0.819	0.699
Observations	34,304	17,320	16,984	34,304	17,320	16,984

Variables	Main effect (1) Total volatility	Low (2) Total volatility	High (3) Total volatility	Main effect (4) Idiosyncratic volatility	Low (5) Idiosyncratic volatility	High (6) Idiosyncratic volatility
Panel B: Firm risk						
BioRisk	0.031** (2.48)	0.035** (2.01)	0.003 (0.19)	0.034** (2.48)	0.037** (1.98)	0.003 (0.19)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.571	0.577	0.586	0.590	0.577	0.608
Observations	34,034	17,398	16,636	34,034	17,398	16,636

Variables	Main effect (1) *ESGScore*	Low (2) *ESGScore*	High (3) *ESGScore*	Main effect (4) *Escore*	Low (5) *Escore*	High (6) *Escore*
Panel C: Sustainability performance						
BioRisk	−0.024** (−2.37)	−0.028** (−2.37)	−0.009 (−0.68)	−0.037*** (−2.74)	−0.048*** (−2.90)	−0.006 (−0.28)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.821	0.825	0.825	0.816	0.812	0.828
Observations	17,130	9222	7908	17,130	9222	7908

Note: This table investigates whether corporate cash holdings mitigate the adverse effects of biodiversity risk on firm performance and sustainability. The sample consists of US public firms from 2000 to 2023. Panel A examines firm performance, where the dependent variables are Return on Assets (ROA) and Tobin's *Q*. Panel B examines firm risk, where the dependent variables are monthly total volatility and monthly idiosyncratic volatility. Panel C examines sustainability performance, where the dependent variables are *ESGScore* and *EScore*. In all panels, the results are reported for the full sample (main effect) as well as for subsamples split by firms' cash holdings. Firms are classified as High (Low) cash if their cash-to-assets ratio is above (below) the annual sample median. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous control variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Overall, these findings indicate that biodiversity risk is associated with adverse implications for firms' future financial performance and ESG profiles. However, higher levels of cash holdings appear to absorb these negative effects, helping firms preserve their growth prospects, reduce volatility and sustain their ESG performance in the face of biodiversity-related pressures.

4.5 | Heterogeneity Analysis

Precautionary cash-holding response to biodiversity risk are unlikely to be uniform across firms. Instead, the magnitude of this response is expected to vary systematically with industry characteristics and firm-level conditions, reflecting heterogeneous operational and financial channels through which biodiversity degradation affects firms' production processes, regulatory exposure, and liquidity management. Accordingly, we conduct a set of cross-sectional analyses to examine how the biodiversity-cash holding relationship varies along four economically meaningful dimensions, including industry-level environmental sensitivity, firms' exposure to environmental fines, dependence on natural resources, and pre-existing liquidity conditions. Table 7 presents the results of our heterogeneity analysis.

Environmental sensitivity captures differences in the extent to which production activities rely on environmental or ecological systems. Firms operating in environmentally sensitive industries are more directly exposed to biodiversity degradation through input disruptions, compliance costs, and heightened scrutiny from regulators and stakeholders. As a result, biodiversity risk is more likely to translate into operational uncertainty and financing frictions in these industries, strengthening incentives to accumulate precautionary cash. In contrast, firms in less environmentally sensitive sectors may face weaker transmission of biodiversity risk into their core operations, dampening the associated liquidity response. Following prior studies (Aerts et al. 2006; Cho and Patten 2007; Ding et al. 2021), we divide the sample into environment-sensitive and non-sensitive industries and re-estimate baseline model for each group.[6] As reported in Columns (1) and (2) of Panel A, the coefficients on *BioRisk* are positive but statistically insignificant in non-sensitive industries, whereas they are

TABLE 7 | Heterogeneity analysis.

	Low		High	
Variables	**(1) *CashTA***	**(2) *CashNA***	**(3) *CashTA***	**(4) *CashNA***
Panel A: Environment sensitivity				
BioRisk	0.011 (1.62)	0.023 (1.01)	0.023*** (3.53)	0.138** (2.21)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.823	0.712	0.905	0.773
Observations	28,805	28,805	7131	7131
	No		**Yes**	
Variables	**(1) *CashTA***	**(2) *CashNA***	**(3) *CashTA***	**(4) *CashNA***
Panel B: Environment fines				
BioRisk	0.009 (1.39)	0.016 (0.82)	0.016** (2.29)	0.025** (2.11)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.896	0.830	0.785	0.628
Observations	13,843	13,843	3478	3478
	Low		**High**	
Variables	**(1) *CashTA***	**(2) *CashNA***	**(3) *CashTA***	**(4) *CashNA***
Panel C: Nature dependence				
BioRisk	0.010 (1.22)	0.014 (0.98)	0.018** (2.24)	0.036** (2.11)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.819	0.775	0.833	0.830
Observations	5171	5171	6092	6092
	Low		**High**	
Variables	**(1) *CashTA***	**(2) *CashNA***	**(3) *CashTA***	**(4) *CashNA***
Panel D: Pre-existing liquidity				
BioRisk	0.012*** (3.68)	0.016*** (3.73)	0.010 (0.90)	−0.007 (−0.12)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.548	0.554	0.799	0.734
Observations	17,962	17,962	17,974	17,974

Note: This table examines the heterogeneity in the relationship between biodiversity risk and corporate cash holdings. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. Panel A splits firms by environmental sensitivity. Panel B splits firms by environmental fines. Panel C splits firms by nature dependence. Panel D splits firms by pre-existing liquidity. All continuous control variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, and ** denote significance at the 1%, and 5% levels, respectively.

positive and significant in environment-sensitive industries. This evidence indicates that firms operating in environmentally exposed industries exhibit stronger precautionary cash-holding responses to biodiversity risk.

Beyond industry-level environmental sensitivity, we turn to firm-level characteristics that shape how biodiversity risk is perceived and internalized. One important source of external pressure at the firm level arises from government enforcement

in the form of environmental fines. Firms that incur environmental penalties face a direct and tangible realization of regulatory and legal risk, typically accompanied by immediate cash outflows. In such settings, biodiversity risk is no longer an abstract or distant concern but becomes salient and financially material, sharpening managers' awareness of downside risk. As a result, these firms are more likely to respond to biodiversity-related uncertainty by strengthening precautionary liquidity safeguards, leading to a stronger cash-holding response as they seek to insure against future penalties and further regulatory tightening. Panel B presents results regarding the firms' exposure to environmental fines. We split the sample based on whether a firm incurs an environmental penalty in a given year and re-estimate Equation (1) for each subsample. For firms without environmental fines, the coefficients on *BioRisk* are insignificant, suggesting that biodiversity-related uncertainty alone does not lead to a meaningful adjustment in cash holdings in the absence of direct regulatory pressure. By contrast, for firms that face environmental fines, *BioRisk* is positively and significantly associated with both measures of cash holdings. These results indicate that biodiversity risk becomes more material when firms are subject to regulatory enforcement. Under such conditions, firms are more inclined to respond by accumulating precautionary cash reserves, consistent with a self-insurance motive against future regulatory costs.

We further examine firm-level heterogeneity arising from differences in reliance on natural capital and ecosystem services (Garel et al. 2025). Firms vary in their reliance on biological resources, which in turn shapes how biodiversity loss translates into operational and financial risk. For firms with a high degree of nature dependence, biodiversity degradation can directly disrupt production inputs and supply chains, posing a direct threat to company operations. Accordingly, internal liquidity becomes particularly valuable as a hedge against input shocks and production interruptions. Consistent with this view, the results in Panel C indicate that the positive association is more pronounced among firms with greater dependence on natural resources.[7] In contrast, for firms whose operations rely less on natural inputs, biodiversity risk is less likely to be perceived as a critical concern, weakening the incentive to adjust cash policies in response.

We next examine whether firms' pre-existing liquidity conditions shape how biodiversity risk is reflected in cash-holding behaviour. Firms enter periods of biodiversity exposure with different baseline cash positions, which may influence the extent to which they rely on liquidity adjustments as a risk-management tool. While firms with greater financial flexibility may already be well insulated against uncertainty, firms with tighter internal liquidity may face stronger incentives to actively adjust cash holdings in response to heightened risk. To capture these pre-existing conditions, we classify firms based on their lagged cash holdings. Panel D reports the results of this analysis. The results indicate that biodiversity risk is positively and significantly associated with cash holdings among firms with low pre-existing liquidity, whereas the corresponding coefficients are statistically insignificant for firms with high pre-existing liquidity. For firms with limited pre-existing liquidity, biodiversity risk is associated with stronger precautionary cash accumulation, whereas firms with ample baseline liquidity show little additional adjustment in cash holdings.

5 | Robustness Check

5.1 | Endogeneity

In our study, endogeneity is unlikely to be a concern since biodiversity risk primarily originates from external factors beyond the firm's control. Moreover, in our model, we incorporate a comprehensive set of control variables to address concerns related to omitted endogenous factors.[8] Nevertheless, in this section, we present three additional tests to further alleviate potential endogeneity issues.

5.1.1 | *PSM and Entropy Balancing*

To address the potential influence of confounding factors that simultaneously affect both cash holdings and biodiversity risk, we employ PSM and entropy balancing and report the results in Panel A of Table 8. We classify firms that have experienced biodiversity risk during the sample period as the treatment group. We then estimate propensity scores using a logit model to determine the probability of a firm belonging to the high biodiversity risk group. We then apply entropy balancing, treating the same firms as the treatment group and balancing the first three moments of covariates between treatment and control groups.[9] Subsequently, we run the regression and find that the coefficients on biodiversity risk remain positive and statistically significant in both the PSM and entropy-balanced samples.

5.1.2 | *Exogenous Shock on Pressures to Cash Holdings*

Although the method proposed by Giglio et al. (2025) relies on textual analysis of firms' 10-K reports as a measure of biodiversity risk, it has potential limitations due to corporate disclosure biases. Specifically, firms may strategically adjust their wording in disclosures to influence how risks are presented, which in turn affects the accuracy of text-based analysis (Li 2008; Loughran and McDonald 2011; Hoberg and Phillips 2016).

To address concerns regarding corporate disclosure strategies and strengthen the causal link between biodiversity risk and cash holdings, we utilize Kunming Declaration of 2021 as an exogenous shock that significantly elevates biodiversity risk awareness. Specially, we adopt a difference-in-differences (DID) approach to mitigate potential endogeneity issues related to unobservable firm-level characteristics (Bourveau and Law 2021). Kunming Declaration was introduced during the first phase of the 15th Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD), held in a hybrid format in Kunming, China, from October 11 to 15, 2021. The full framework was later adopted in December 2022 at the second phase of COP15 in Montreal, setting out four overarching goals and 23 specific targets, including the landmark "30×30" target to protect 30% of the planet's land and sea by 2030, with the overarching ambition of halting and reversing biodiversity loss by 2050. Following prior studies (Ginglinger and Moreau 2023; Hossain et al. 2023; Feng et al. 2024), we first construct an indicator variable, *Post*, which equals 1 for observations from 2022 to 2023, and 0 for those from 2020 to 2021. Next, we classify firms that had already faced biodiversity risk before 2021 as the treatment group ($Treat = 1$). We then replace the biodiversity risk measure in our baseline specification with

TABLE 8 | Endogeneity tests.

Variables	PSM sample (1) *CashTA*	PSM sample (2) *CashNA*	EB sample (3) *CashTA*	EB sample (4) *CashNA*
Panel A: PSM and entropy balancing				
BioRisk	0.015*** (3.71)	0.029*** (3.42)	0.015*** (3.81)	0.043* (1.75)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.737	0.722	0.750	0.716
Observations	5066	5066	35,426	35,426

Variables	(1) *CashTA*	(2) *CashNA*
Panel B: Quasi-natural experiment		
*Treat*Post*	0.013** (2.21)	0.072** (2.40)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Adj R^2	0.927	0.854
Observations	6443	6443

Note: This table addresses potential endogeneity concerns in the relationship between biodiversity risk and corporate cash holdings. Panel A reports the results using a propensity score matched (PSM) sample and an entropy balancing (EB) sample. Panel B reports the results of a quasi-natural experiment, using the Kunming–Montreal Global Biodiversity Framework as an exogenous shock to biodiversity risk. We construct an indicator variable *Post*, which equals 1 for observations in 2022–2023 and 0 for those in 2020–2021. Firms that had already faced biodiversity risk before 2021 are classified as the treatment group (*Treat* = 1), while the remaining firms serve as the control group (*Treat* = 0). The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

the interaction term *Treat*Post*, while the main effects of *Post* and *Treat* are absorbed by firm and year fixed effects.

Panel B of Table 8 reports the results. The coefficient on *Treat*Post* is positive and statistically significant, indicating that firms with higher biodiversity risk increased their cash holdings after the introduction of 2021 Kunming Declaration. This finding suggests that, in the post-Kunming Declaration period, investors and financial institutions placed greater weight on biodiversity risk, thereby intensifying regulatory scrutiny and raising the likelihood of stricter environmental policies. Consequently, firms exposed to biodiversity risk responded by holding additional cash as a precautionary measure to hedge against uncertainties associated with evolving regulations and shifting market expectations.

5.2 | Alternative Specifications of Cash Holdings

In the main analysis, we measure corporate cash holdings using the ratio of cash and cash equivalents to book assets, and the ratio of cash and cash equivalents to net assets. As a robustness check, we follow prior literature (Opler 1999; Dittmar and Mahrt-Smith 2007; Harford et al. 2008; Subramaniam et al. 2011; Cheung 2016; Xu et al. 2016; Ni 2019; El Kalak and Tosun 2022; Di et al. 2024; Elnahas et al. 2024; Chen et al. 2025) and adopt alternative definitions of firm cash holdings. Specifically, we consider the following measures in Table 9: The log value of cash and cash equivalents divided by book assets, reported in Column (1); the log value of cash and cash equivalents divided by net assets, reported in Column (2); cash and cash equivalents divided by sales, reported in Column (3); the log value of cash and cash equivalents divided by sales, reported in Column (4); industry-adjusted cash holdings, reported in Column (5).[10] Finally, we use the change of cash holdings, reported in Column (6). The results remain consistent and robust.

5.3 | Decomposing Biodiversity Risk

So far, we used a composite measure that integrates both dimensions of biodiversity risk. To gain further insights, we conduct additional analyses on each individual component. According to Giglio et al. (2025), the measurement of biodiversity risk can be decomposed into two distinct dimensions: (1) Biodiversity Negative, which captures only negative mentions of biodiversity risks using sentiment analysis and (2) Biodiversity Regulation, which specifically identifies biodiversity-related risks associated with regulatory concerns (e.g., laws, restrictions, and regulations). Specifically, the firm's Biodiversity-Negative score (*Bio-Negative*) is computed by using number of negative biodiversity sentences minus the number of positive sentences. A high (more negative) score means that, on net, the firm's disclosures have a predominantly adverse tone regarding biodiversity risk. This negative sentiment score serves as a proxy for how much concern the firm expresses about the potential adverse effects of biodiversity loss on its operations, supply chains, or market position. In addition, the second dimension (Biodiversity-Regulation) focuses on how companies

TABLE 9 | Alternative measures of cash holdings.

Variables	(1) ln(*CashTA*)	(2) ln(*CashNA*)	(3) *CashSale*	(4) ln(*CashSale*)	(5) *Ind adjust Cash*	(6) Δ*Cash*
BioRisk	0.203*** (3.02)	0.239*** (3.46)	0.087*** (2.99)	0.208*** (2.77)	0.020*** (4.22)	0.025* (1.70)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.772	0.810	0.664	0.834	0.770	0.321
Observations	35,026	35,026	35,026	35,026	35,026	35,026

Note: This table presents robustness tests of the impact of biodiversity risk on corporate cash holdings using alternative definitions of cash holdings. Column (1) uses log value of cash and cash equivalents divided by book assets. Column (2) uses log value of cash and cash equivalents divided by net assets. Column (3) uses cash and cash equivalents divided by sales. Column (4) uses log value of cash and cash equivalents divided by sales. Column (5) uses industry-adjusted cash holdings. Column (6) uses changes in cash and cash equivalents divided by net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *** and * denote significance at the 1% and 10% levels, respectively.

TABLE 10 | Specific components of biodiversity risk.

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
Bio-Negative	0.014* (1.74)	0.051* (1.75)		
Bio-Regulation			0.030*** (4.67)	0.119*** (2.93)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj R^2	0.856	0.767	0.856	0.767
Observations	35,936	35,936	35,936	35,936

Note: This table reports the impact of specific components of biodiversity risk on corporate cash holdings. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. We use two components of biodiversity risk. *Bio-Negative* captures only negative mentions of biodiversity risks using sentiment analysis. *Bio-Regulation* captures risks associated with biodiversity-related regulatory concerns. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *** and * denote significance at the 1% and 10% levels, respectively.

discuss regulatory risks related to biodiversity in their filings. This score is designed to isolate the aspects of biodiversity discussions that mention potential regulatory actions, such as new laws, restrictions, or regulatory interventions that could affect the firm's operations. It captures biodiversity risk from the subset of concerns that arise specifically from regulatory frameworks. Regulatory risks can have a direct impact on business operations, through increased compliance costs, operational restrictions, or even the possibility of litigation if standards are not met.

Table 10 shows that both negative sentiment (*Bio-Negative*) and regulatory concerns (*Bio-Regulation*) aspects of biodiversity risk have a significant impact, as reflected in their positive and significant coefficients. Our findings demonstrate that both negative sentiment and regulatory concerns related to biodiversity risk have a positive impact on cash holdings.

5.4 | Distinguishing Biodiversity Risk from Climate Change Risk

An important concern is whether the observed effect of biodiversity risk on corporate cash holdings is simply capturing the influence of climate change risk. To address this issue, we explicitly control for multiple measures of climate-related risk and disclosure.

Panel A of Table 11 incorporates Sautner et al.'s (2023) climate change exposure index.[11] Across all specifications, the coefficient on *BioRisk* remains positive and statistically significant, suggesting that the impact of biodiversity risk on cash holdings is not subsumed by general climate change concerns. Panel B further employs Li et al.'s (2024) classification of climate risks, which distinguishes between physical and transition risks.[12] Even after accounting for these dimensions, *BioRisk* continues to exhibit a significant positive association with cash holdings, indicating that biodiversity risk reflects factors beyond conventional climate risk channels. Finally, Panel C introduces Berkman et al.'s (2024) firm-specific climate disclosure score.[13] The results show that while climate disclosure itself does not drive higher cash holdings, the coefficients on *BioRisk* remain both positive and significant.

Therefore, these findings suggest that the relationship between biodiversity risk and corporate cash holdings is not merely a reflection of climate change risk. Rather, biodiversity risk plays an independent effect,[14] driving firms to hold additional cash as a reserve against the unique uncertainties associated with biodiversity loss and regulatory responses.

TABLE 11 | Distinguishing biodiversity risk from climate change risk.

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(5) *CashTA*	(6) *CashNA*	(7) *CashTA*	(8) *CashNA*	(9) *CashTA*	(10) *CashNA*
Panel A: Climate change exposure index (Sautner et al. 2023)										
BioRisk	0.019***	0.065***	0.019***	0.066***	0.019***	0.065***	0.019***	0.066***	0.019***	0.065***
	(3.72)	(2.84)	(3.71)	(2.84)	(3.74)	(2.87)	(3.75)	(2.87)	(3.72)	(2.85)
CCExpo	0.002	0.013***								
	(1.57)	(3.04)								
OPExpo			0.004	0.026***					0.003	0.022**
			(1.60)	(2.89)					(1.40)	(2.48)
RGExpo					0.013**	0.098***			0.011*	0.084***
					(2.05)	(3.45)			(1.75)	(3.00)
PHExpo							−0.014	−0.048	−0.017	−0.070
							(−0.94)	(−0.52)	(−1.15)	(−0.75)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	YES	YES
Adj R^2	0.856	0.757	0.856	0.757	0.856	0.757	0.856	0.757	0.857	0.757
Observations	28,771	28,771	28,771	28,771	28,771	28,771	28,771	28,771	28,771	28,771

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(5) *CashTA*	(6) *CashNA*	(7) *CashTA*	(8) *CashNA*	(9) *CashTA*	(10) *CashNA*	(11) CashTA	(12) CashNA
Panel B: Climate change risks (Li et al. 2024)												
BioRisk	0.021***	0.061**	0.021***	0.062**	0.021***	0.061**	0.021***	0.061**	0.021***	0.061**	0.021***	0.062**
	(3.29)	(2.45)	(3.30)	(2.47)	(3.28)	(2.44)	(3.26)	(2.44)	(3.26)	(2.44)	(3.31)	(2.48)
TranRisk	0.004 (1.39)	0.007 (0.70)									0.010 (0.45)	0.013 (0.13)
TranRisk_Pro			0.004*	0.015*							0.002 (0.51)	0.014 (1.10)
			(1.91)	(1.86)								
TranRisk_NPro					0.003 (1.19)	0.004 (0.42)						
−0.007 (−0.36)												
−0.015 (−0.16)	*PhyRis-k_Acute*							0.002 (1.05)	0.004 (0.69)			0.002 (0.85)
0.003 (0.54)												
PhyRisk_Chronic									0.003**	0.007 (1.46)	0.003**	0.006 (1.39)
									(2.09)		(1.99)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(Continues)

TABLE 11 | (Continued)

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(5) *CashTA*	(6) *CashNA*	(7) *CashTA*	(8) *CashNA*	(9) *CashTA*	(10) *CashNA*	(11) CashTA	(12) CashNA
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.869	0.778	0.869	0.778	0.869	0.778	0.869	0.778	0.869	0.778	0.869	0.778
Observations	20,139	20,139	20,139	20,139	20,139	20,139	20,139	20,139	20,139	20,139	20,139	20,139

Variables	(1) CashTA	(2) CashNA
Panel C: Firm-specific climate disclosure score (Berkman et al. 2024)		
BioRisk	0.021***	0.047* (1.68)
	(3.00)	
ClimateDisclosure		−0.000 (−0.32)
0.000* (1.76)		
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Adj R^2	0.899	0.811
Observations	12,466	12,466

Note: This table examines whether the effect of biodiversity risk on corporate cash holdings is distinct from that of climate change risk. The dependent variables are *CashTA*, measured by the ratio of cash and cash equivalents to total assets, and *CashNA*, measured by the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. Panel A includes Sautner et al.'s (2023) climate change exposure index, Panel B uses Li et al.'s (2024) classification of climate risks, and Panel C includes Berkman et al.'s (2024) firm-specific climate disclosure score as additional controls. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

TABLE 12 | Other sensitivity tests.

Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*
Panel A: High-dimensional fixed effects				
BioRisk	0.020*** (3.99)	0.067** (2.32)	0.018*** (3.94)	0.061** (2.02)
Controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year × State FE	Yes	Yes	Yes	Yes
Adj R^2	0.821	0.727	0.856	0.759
Observations	35,067	35,067	35,067	35,067

Variables	(1) *CashTA*	(2) *CashNA*
Panel B: Excluding all-zero biodiversity risk observations		
BioRisk	0.013*** (3.39)	0.024*** (3.10)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Adj R^2	0.730	0.740
Observations	3094	3094

	Exclude financial crisis		Exclude COVID-19		Exclude abnormal business shocks	
Variables	(1) *CashTA*	(2) *CashNA*	(3) *CashTA*	(4) *CashNA*	(5) *CashTA*	(6) *CashNA*
Panel C: Excluding major economic and business shocks						
BioRisk	0.020*** (4.04)	0.084** (2.55)	0.022*** (4.34)	0.090*** (2.71)	0.020*** (4.18)	0.059*** (2.62)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.857	0.771	0.853	0.762	0.858	0.773
Observations	33,124	33,124	32,479	32,479	34,847	34,847

Note: This table reports the results of other sensitivity test. Panel A uses high-dimensional fixed effects to address potential unobserved heterogeneity. We include Year × State fixed effects, controlling for time-varying shocks at the state level. Panel B reports the results after excluding firms with no biodiversity exposure, namely, all firm-year observations for firms whose biodiversity risk index equals zero throughout the sample period. Panel C excludes major economic shocks. The dependent variables are *CashTA*, measured as the ratio of cash and cash equivalents to total assets, and *CashNA*, measured as the ratio of cash and cash equivalents to net assets. *BioRisk* is a dummy variable equal to 1 if a firm faces biodiversity risk in a given year, and 0 otherwise. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *** and ** denote significance at the 1% and 5% levels, respectively.

5.5 | Other Sensitivity Tests

To further ensure the robustness of our findings, we conduct a series of additional sensitivity tests, with the results reported in Table 12.

First, we introduce year-by-state fixed effects to absorb time-varying, location-specific shocks, including changes in state-level regulation, economic conditions, and biodiversity-related policies. We present the results in Panel A. Second, ensuring identification is driven by meaningful variation in biodiversity exposure, we exclude firms with no biodiversity risk throughout the sample period. We reported the results in Panel B. Third, we address concerns that our results may be driven by major macroeconomic or firm-level shocks. We exclude observations during the global financial crisis (2008–2009) and the COVID-19 period (2020–2021). In addition, we follow Owens et al. (2017) and exclude observations experiencing significant business disruptions. The results of these tests are presented in Panel C. Our original conclusions remain unchanged.

6 | Conclusion

This study provides novel evidence on how biodiversity risk shapes corporate liquidity policies. We show that firms exposed to higher biodiversity risk hold more cash, consistent with the precautionary motive. Our analysis further uncovers the mechanisms underlying this relationship, documenting that internal CSR governance and external institutional pressures drive firms' precautionary cash policies. We also find that firms accumulate cash mainly by reducing discretionary expenditures in R&D and capital investment rather than by raising external financing. Importantly, higher cash holdings help mitigate the negative financial and ESG consequences of biodiversity risk by supporting firm performance and growth opportunities, reducing volatility, and protecting sustainability reputations.

By focusing on biodiversity as a distinct dimension of environmental risk, our findings extend the corporate finance literature on cash holdings beyond the well-studied context of climate risk. We demonstrate that biodiversity loss represents a material source of

uncertainty that firms cannot ignore. For managers, integrating biodiversity considerations into risk management and financial planning is critical to ensure resilience. For investors, our results highlight the need to incorporate biodiversity exposure into risk assessment and asset valuation. For policymakers, the evidence suggests that well-designed biodiversity frameworks can influence corporate financial behaviour without necessarily constraining firms' resilience.

Despite its contributions, this study has several limitations that suggest avenues for future research. First, our biodiversity risk measures are based on corporate disclosures, which may capture reporting behaviour and managerial awareness rather than firms' full underlying exposure; future research could incorporate more comprehensive biodiversity data to enhance measurement precision. In addition, while this study focuses on cash holdings as a key financial response, future work could examine how biodiversity risk affects other corporate decisions, such as capital structure, innovation, or investment strategies, and explore cross-country contexts with differing institutional and biodiversity environments.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Endnotes

[1] Data are available at https://www.biodiversityrisk.org/

[2] We also provide alternative proxies of cash holdings in robustness check.

[3] Table A2 presents sample selection process.

[4] The economic significant is calculated as the coefficient of *BioRisk* (0.020) divided by the average value of *cash holdings* (0.218)

[5] Data are available at https://www.daphnemarmstrong.com/data

[6] Environment-sensitive firms are classified as those operating in the following SIC industries: oil exploration (SIC 1300–1399), paper (SIC 2600–2699), chemical and allied products (SIC 2800–2899), petroleum refining (SIC 2900–2999), metals (SIC 3300–3399), mining (SIC 1000–1099), and utilities (SIC 4900–4999).

[7] Data are available at https://osf.io/d85e7/overview

[8] Results using 1-year lag biodiversity risk remain consistent.

[9] The descriptive statistics for pre-matching and post-matching samples are presented in Table A3.

[10] We compute the median levels of the cash holdings within the industry-year categories. The industry-adjusted measure is then calculated as the firm's cash holdings minus the median industry-year level of the cash holdings.

[11] Their website is https://osf.io/fd6jq/

[12] Data are available at https://www.corporateclimaterisk.com/

[13] Data are available at https://sites.google.com/view/climateriskdata/research

[14] Our untabuled results show that the correlation between biodiversity risk and climate change exposure is 0.0534, and the correlation between biodiversity risk and climate change risk is 0.0379.

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Appendix A

TABLE A1 | Variables definition.

Variable name	Definition	
CashTA	Cash and cash equivalents scaled by total assets	Compustat
CashNA	Cash and cash equivalents divided by net assets	Compustat
ln(*CashTA*)	Log value of cash and cash equivalents divided by book assets	Compustat
ln(*CashNA*)	Log value of cash and cash equivalents divided by net assets	Compustat
CashSale	Cash and cash equivalents divided by sales	Compustat
ln(*CashSale*)	Log value of cash and cash equivalents divided by sales	Compustat
Ind adjust Cash	Industry-adjusted cash holdings which is calculated as the firm's cash holdings minus the median industry-year level of the cash holdings	Compustat
Δ*Cash*	Changes in cash and cash equivalents scaled by total assets	Compustat
BioRisk	An indicator that assesses whether a company acknowledges biodiversity-related risks in its 10-K filings by mentioning biodiversity in at least two separate sentences	Giglio et al. (2025)
Bio-Negative	Biodiversity-Negative Score which captures only negative mentions of biodiversity risks using sentiment analysis	Giglio et al. (2025)
Bio-Regulation	Biodiversity-Regulation Score which captures biodiversity-related risks associated with regulatory concerns	Giglio et al. (2025)
SIZE	Natural logarithm of Book Assets	Compustat
MB	Market to book ratio is the ratio of total assets plus market value of equity minus book value of equity divided by total assets	Compustat
LEV	Total debt over total assets	Compustat
Growth	Annual percentage change of Sales	Compustat
Cashflow	Net cash flow from operations scaled by total assets	Compustat
Dividend Dummy	Dummy variable coded 1 if a firm pays dividend in current year and 0 otherwise	Compustat
STD_CFO	Standard deviation of operating cash flow scaled by total assets for the previous 5 years	Compustat
RD	R&D expenses scaled by total assets. We replace missing values of R&D expenditure by zeros	Compustat
CAPX	Capital expenditures scaled by total assets	Compustat
NWC	The difference between current assets and current liabilities excluding cash and cash equivalent, scaled by total assets	Compustat
Acquisition	Expenditures on acquisitions scaled by total assets. We replace missing values of acquisitions expenditure by zeros	Compustat
SGA	Selling, general, and administrative expendures, excluding R&D, scaled by total assets	Compustat
CSR-linked Compensation	Dummy variable coded 1 if the senior executive's compensation linked to CSR/H&S/ Sustainability targets, and 0 otherwise	Refinitiv
ESG-linked Pay	Dummy variable coded 1 if the company have an extra-financial performance-oriented compensation policy. The compensation policy includes remuneration for the CEO,	Refinitiv

(Continues)

TABLE A1 | (Continued)

Variable name	Definition	
	executive directors, non-board executives, and other management bodies based on ESG or sustainability factors, and 0 otherwise.	
CSR Committee	Dummy variable coded 1 if the company have a CSR committee or team on board level or Senior management committee responsible for decision making on CSR strategy, and 0 otherwise	Refinitiv
Environmental Management Team	Dummy variable coded 1 if the company have an environmental management team (at any level) dedicated to environmental issues, and 0 otherwise	
Sustainability Reporting	Dummy variable coded 1 if the company publish a separate CSR/H&S/Sustainability report or publish a section in its annual report on CSR/H&S/Sustainability, and 0 otherwise	Refinitiv
Biodiversity Impact Reporting	Dummy variable coded 1 if the company report on its impact on biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas, and 0 otherwise	Refinitiv
Environmental Expenditures/ Investments	Dummy variable coded 1 if the company report on its environmental expenditures or report to make proactive environmental investments to reduce future risks or increase future opportunities, and 0 otherwise	Refinitiv
Nature dependence	Dummy variable coded 1 if the firm's nature dependence index is greater than zero, and 0 otherwise	Garel et al. (2025)
Total volatility	Square root of 12 multiplied by the standard deviation of monthly stock returns	CRSP
Idiosyncratic volatility	Square root of 12 multiplied by the standard deviation of monthly excess stock returns. Excess return is defined using a Capital Asset Pricing Model (CAPM) market model estimated over the prior year	CRSP
ROA	Ratio of net income to total asset	Compustat
Tobin *Q*	Market value of the firm (book value of asset less the book value of the equity, plus the market value of the equity), divided by book value of the assets	Compustat
ESGScore	Refinitiv overall ESG score	Refinitiv
Escore	Refinitiv environment pillar score	Refinitiv
CSR score	The average of Refinitiv environment pillar score and social pillar score	Refinitiv
Equity Issue	Ratio of the difference between sale and purchase to total assets	Compustat
Debt Issue	Ratio of the difference between long-term debt issuance and long-term debt reduction to total assets	Compustat
Total Issue	Ratio of equity issued plus debt issued to total assets	Compustat
CCExpo	A company's current level of climate change exposure to regulatory, physical, and opportunity climate change shocks. Higher value of this index indicatesmore climate change exposure	Sautner et al. (2023)
OPExpo	A company's current level of climate change exposure to opportunity climate change shocks. Higher value of this index indicates more climate risk exposure	Sautner et al. (2023)
RGExpo	A company's current level of climate change exposure to regulatory climate change shocks. Higher value of this index indicates more climate risk exposure	Sautner et al. (2023)
PHExpo	A company's current level of climate change exposure to physical climate change shocks. Higher value of this index indicates more climate risk exposure	Sautner et al. (2023)
CCRisk	A company's current level of climate change risk to regulatory, physical, and opportunity climate change shocks. Higher value of this index indicatesmore climate change risk	Sautner et al. (2023)
ClimateDisclosure	Scores for climate change disclosure extensiveness and relevance	Berkman et al. (2024)
TranRisk	The frequency of mentions of the unigrams or bigrams related to the transition climate discussion, scaled by the total length of the transcript	Li et al. (2024)
TranRisk_Pro	The frequency of mentions of the unigrams or bigrams related to the transition climate discussion in the proximity of proactive verbs, divided by the total length of the transcript	Li et al. (2024)

(Continues)

TABLE A1 | (Continued)

Variable name	Definition	
TranRisk_NPro	The frequency of mentions of the unigrams or bigrams related to the transition climate discussion which are not in the proximity of proactive verbs, divided by the total length of the transcript	Li et al. (2024)
PhyRisk_Acute	The frequency of mentions of the unigrams or bigrams related to the acute climate discussion in the proximity of risk synonyms, divided by the total length of the transcript	Li et al. (2024)
PhyRisk_Chronic	The frequency of mentions of the unigrams or bigrams related to the chronic climate discussion in the proximity of risk synonyms, divided by the total length of the transcript	Li et al. (2024)

TABLE A2 | Sample selection.

	Firm-year observations
All firm-year observations of firms incorporated in the United States in the Compustat Fundamentals Annual database from 1997 to 2023	231,576
Less	
Excluding firm-year observations with negative or zero asset and sales	11,415
Excluding firm-year observations with missing data for biodiversity risk indicator	170,722
Excluding firm-year observations with missing cash holdings	74
Observations with missing control variables	10,179
Excluding financial (SIC codes 6000–6999) and utility firms (SIC codes 4900–4999)	3250
Final sample (4003 firms)	35,936

Note: In this table, we provide sample selection process for our full sample. Definitions of variables and data sources are provided in Table A1.

TABLE A3 | Covariate balance test.

	Treat			Control		
	Mean	**Variance**	**Skewness**	**Mean**	**Variance**	**Skewness**
Panel A: Before						
SIZE	7.893	2.348	0.009	7.014	2.882	0.399
MB	1.803	1.305	3.456	2.474	3.470	2.404
LEV	0.293	0.036	0.803	0.224	0.045	1.003
Growth	0.163	0.212	3.648	0.187	0.248	4.409
Cashflow	0.108	0.008	−1.035	0.071	0.018	−1.836
Dividend Dummy	0.599	0.240	−0.405	0.412	0.242	0.357
STD_CFO	0.043	0.002	3.123	0.056	0.005	3.172
RD	0.009	0.001	8.574	0.055	0.009	2.477
CAPX	0.085	0.006	1.435	0.043	0.002	2.553
NWC	0.049	0.014	0.508	0.047	0.023	0.025
Acquisition	0.022	0.003	3.605	0.028	0.004	3.161
SGA	0.114	0.020	1.869	0.203	0.047	0.601
Panel B: After						
SIZE	7.893	2.348	0.009	7.893	2.348	0.010
MB	1.803	1.305	3.456	1.803	1.305	3.456
LEV	0.293	0.036	0.803	0.293	0.036	0.803
Growth	0.163	0.212	3.648	0.163	0.212	3.648
Cashflow	0.108	0.008	−1.035	0.108	0.008	−1.035
Dividend Dummy	0.599	0.240	−0.405	0.599	0.240	−0.405
STD_CFO	0.043	0.002	3.123	0.043	0.002	3.124
RD	0.009	0.001	8.574	0.009	0.001	8.572
CAPX	0.085	0.006	1.435	0.085	0.006	1.435
NWC	0.049	0.014	0.508	0.049	0.014	0.508
Acquisition	0.022	0.003	3.605	0.022	0.003	3.605
SGA	0.114	0.020	1.869	0.114	0.020	1.869