Examining the Financial Impact of Biodiversity-Related Reputational Disasters

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Abstract

This research investigates the reaction of financial markets to biodiversity-related corporate events, utilising an EGARCH model to assess the implications on stock returns and volatility. Results reveal that markets significantly respond to these events, demonstrating heightened sensitivity and volatility that underscore the financial relevance of biodiversity risks. We find that investors differentiate between events based on their novelty and severity, reflecting a nuanced valuation approach towards environmental information, highlighting the importance of transparency and the role of information asymmetry in market efficiency. Our findings advocate for stricter disclosure requirements and enhanced regulatory frameworks to improve market transparency concerning environmental risks. This research underscores the urgent need for integrating biodiversity considerations into financial decision-making and regulatory policies, emphasising the potential of informed markets to contribute to environmental sustainability.

Keywords: Biodiversity; ESG; CSR; Stock Market Returns; EGARCH; Reputational Risk.
JEL Classification: G10; G14; G32; Q56; M14.

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1. Introduction

Biodiversity loss poses significant risks to companies, impacting them through regulatory, supply chain, reputational, and financial channels. Stricter environmental regulations to preserve biodiversity can introduce compliance challenges, leading to legal repercussions, operational hindrances, and elevated costs for non-compliant firms. Industries dependent on natural resources, such as agriculture, pharmaceuticals, and cosmetics, are particularly vulnerable to disruptions in supply chains and increased costs resulting from the depletion of critical ecosystems and species. Reputationally, companies implicated in harming biodiversity face considerable risks. Enhanced public and stakeholder consciousness regarding environmental sustainability can trigger adverse reactions, tarnishing brand image, eroding consumer trust, and potentially diminishing market value. In today's digital era, the rapid dissemination of information can magnify these effects, underscoring the importance of maintaining a positive environmental image. Financially, the shift towards integrating Environmental, Social, and Governance (ESG) criteria into investment strategies signifies a growing market aversion to environmental risks. Companies with poor environmental practices are finding themselves at a disadvantage, facing divestment and a higher cost of capital. This trend underlines the critical need for businesses to prioritise sustainability and biodiversity conservation as part of their risk management and strategic planning to safeguard their market position and financial health in an increasingly environmentally conscious economic landscape.

Biodiversity-related reputational events refer to incidents or disclosures that potentially impact a firm's reputation due to its practices or impacts on biodiversity, as derived from a novel dataset obtained from the RepRisk database. This dataset encompasses a wide range of events, from legal violations and regulatory non-compliance to negative publicity surrounding a company's environmental impact. The choice of RepRisk's dataset is motivated by its comprehensive coverage of environmental and reputational risks, offering a unique perspective through which to analyse the financial market's response to biodiversity concerns. The importance of this topic cannot be overstated; as investors and stakeholders increasingly prioritise sustainability, the ability of companies to manage their biodiversity impact not only influences their reputational standing but also affects their financial performance and market valuation. This research underscores the critical need for firms to adopt robust environmental risk management and disclosure practices, highlighting the growing influence of biodiversity conservation on investment decisions and corporate strategies in the global push towards sustainability.

This research addresses several pivotal questions surrounding environmental sustainability and financial market dynamics while specifically focusing on biodiversity-related corporate events. The primary research questions are: 1) How do financial markets react to the announcement and occurrence of biodiversity-related corporate events regarding stock returns and market volatility? This question sought to quantify the immediate and residual market sensitivity to environmental incidents; 2) To what extent does information asymmetry affect market efficiency in the context of biodiversity events? Here, the focus was on understanding the role of information availability and transparency in shaping investor responses and market adjustments; and 3) How do investors differentiate between various types of biodiversity-related risks, particularly considering the novelty and severity of such events? This latter question explores investors' valuation approaches when faced with differing environmental risks.

Understanding the financial market response to biodiversity-related corporate events is crucial for several reasons. Firstly, as global awareness of environmental issues grows, the financial implications of corporate sustainability practices are becoming increasingly significant for investors, corporations, and policymakers alike. This research sheds light on how biodiversity events impact financial markets, offering insights into investor behaviour and market dynamics in the face of environmental risks. By quantifying the effects of these events on stock returns and volatility, the study contributes to the development of more robust financial models that integrate environmental risks, enhancing the predictive accuracy of market reactions to sustainability-related incidents. Secondly, this research underscores the importance of transparency and disclosure in mitigating information asymmetry, a key factor influencing market efficiency. Improved understanding of these dynamics aids in formulating regulatory policies that encourage more transparent disclosure of environmental risks, leading to more informed investment decisions. Finally, exploring how investors differentiate between various biodiversity risks based on their novelty and severity provides valuable insights into the complexity of market valuations in response to environmental incidents.

Results indicate that financial markets exhibit significant sensitivity to biodiversity-related corporate events, with distinct reactions regarding stock returns and volatility, highlighting the importance of environmental considerations in market valuations. Specifically, results indicate an immediate market reaction to such events, characterised by increased volatility and notable shifts in stock prices, suggesting that investors actively incorporate environmental information into their decision-making processes. Further, the findings reveal a nuanced investor response based on the novelty and severity of biodiversity incidents, indicating a sophisticated market approach to evaluating environmental risks. Policy implications of this research are distinct, advocating for enhanced disclosure standards and regulatory frameworks to address information asymmetry and improve market transparency regarding environmental risks. The necessity for stricter environmental risk disclosure requirements emerges as a pivotal theme, aiming to facilitate more informed and efficient market responses. Additionally, establishing standards to counter misinformation and provide accurate reporting on corporate environmental impacts is deemed critical.

The remainder of the paper is structured as follows: the previous literature and theories that guide the development of our research are summarised in Section 2. Section 3 presents a thorough explanation of the wide variety of data used in such analysis while presenting a concise overview of the methodologies used. Section 4 specifically investigates the influence of biodiversity-related reputationally damaging events while further investigating whether the distinct corporate characteristics, including CSR and ESG performance, have acted as a primary explanatory factor towards observed differentials of response within the results. A further brief discussion of the policy-based implications of the presented results is provided in Section 5, while Section 6 concludes.

2. Previous Literature and Theoretical Foundations

Recent research has extensively analysed the intersection between financial markets and biodiversity, focusing on how biodiversity risks impact asset pricing, the significance of corporate biodiversity footprints, and the influence of ESG investing and green finance on market dynamics and corporate behaviour. Coqueret and Giroux [2023] provides an empirical asset pricing analysis that presents how biodiversity risks, distinct from carbon risks, are integrated into asset returns, particularly in sectors highly exposed to such risks. The study demonstrates the financial market's increasing attention to biodiversity issues, reflecting both expected and realised returns and highlighting the need for biodiversity considerations in investment decisions. Garel et al. [2023] introduces the Corporate Biodiversity Footprint (CBF) as a measure of a firm's impact on biodiversity, revealing post-COP15 a growing market premium for stocks with significant biodiversity footprints. This shift indicates an evolving investor response to biodiversity risks, driven by anticipation of future regulations and a broader recognition of the importance of biodiversity conservation. While Van der Beck [2021], Pedersen et al. [2021], and Pástor et al. [2021] explore the effects of ESG investing and green finance on asset pricing and corporate behaviour. They illustrate how capital flows into sustainable mutual funds and how integrating ESG criteria into investment strategies significantly influences the pricing and returns of green stocks, encouraging corporate sustainability efforts and indirectly supporting biodiversity conservation. Bolton and Kacperczyk [2021, 2023] discuss the carbon premium in the market, indicating investors' demand for compensation for exposure to carbon emission risk, which is reflective of a broader environmental risk framework that also encompasses biodiversity risks. These studies suggest that financial markets increasingly value firms' environmental impacts, including their biodiversity footprints. Ardia et al. [2023] and Zhang [2023] further confirm the market's responsiveness to environmental concerns, showing how green firms tend to outperform brown firms in periods of heightened climate change concerns. This responsiveness is attributed to the market mechanisms favouring environmentally friendly practices, which are crucial for biodiversity conservation. Such studies underscore the complex relationship between financial markets and biodiversity, demonstrating that biodiversity risks, corporate environmental impacts, and sustainable investment practices significantly influence asset pricing, investor behaviour, and corporate strategies. They highlight the growing recognition of biodiversity conservation in financial decision-making, emphasising the potential of market-based incentives to promote environmental sustainability and biodiversity conservation.

Integrating biodiversity conservation into corporate strategies is a multifaceted challenge, necessitating a nuanced understanding of the interplay between economic activities, environmental policy, and sustainable development. Leippold et al. [2024] investigate the financial and policy implications of US firms' climate lobbying efforts, underscoring the broader environmental impacts, including biodiversity conservation. This is complemented by Escobar and Vredenburg [2011] and D'Amato et al. [2018], who investigate sustainable development within multinational oil companies and forestry management in China, revealing diverse approaches to environmental pressures and the integration of biodiversity in corporate decision-making. The effectiveness of green investing in reducing emissions, as explored by De Angelis et al. [2023], alongside the motivations for corporate ecological actions discussed by Bansal and Roth [2000], highlight the role of market-based incentives and regulatory compliance in promoting sustainable practices.

Further, Di Giuli and Kostovetsky [2014] and Kang [2016] focused on the financial and political dimensions of Corporate Social Responsibility (CSR), pointing to the influence of political leanings and lobbying on environmental policy and CSR activities within the energy sector. Collectively, these studies underscore the critical role of corporate strategies in achieving environmental stewardship alongside economic development, advocating for effective interventions, stakeholder engagement, and integrating financial and political strategies for biodiversity conservation. Focusing on corporate sustainability strategies, research by Boiral [2016], Boiral and Heras-Saizarbitoria [2017], Anthony and Morrison-Saunders [2023] and Schimanski et al. [2023] highlights the challenges and opportunities in biodiversity impact reporting, stakeholder engagement, and nature-related corporate communications. These studies stress the need for transparent reporting, accountability, and leveraging financial incentives to mitigate adverse industry impacts on biodiversity, pointing to a market premium for companies with lower emissions, as discussed by Hsu et al. [2023]. Karolyi and Tobin-de la Puente [2023] and Flammer et al. [2023] emphasise the potential of private and blended finance in bridging investment shortfalls and fostering sustainable biodiversity management by addressing the financing gap in biodiversity conservation. Zeng et al. [2024] further explored the role of FinTech and sustainable financing in promoting low-carbon transitions, especially within BRICS economies, underscoring the importance of financial innovation in biodiversity conservation efforts.

3. Data and Methodology

3.1. Data

Data based on events relating to impacts on landscapes, ecosystems and biodiversity are obtained from the RepRisk database, which has been used in research to date that has focused on transparency, corporate social responsibility, and investigation of ESG-focused issues, amongst other areas [Akyildirim et al., 2020]. Data is obtained along with several related characteristics, presenting the specific analysis of the reputational event's severity, novelty, and reach. Within the RepRisk database, each risk incident is analysed according to three parameters: 1) Severity constitutes the harshness of the risk incident or criticism; 2) Reach of the information source (influence based on readership/circulation as well as by its importance in a specific country); and 3) novelty (newness) of the issues addressed for the company and project, whether it is the first time a company/project is exposed to a specific ESG issue in a specific location. One of the ESG issues among RepRisk core issues is impacts on landscapes, ecosystems, and biodiversity. It is defined as the impacts of company activities on ecosystems or landscapes such as forests, rivers, seas, etc., contamination of groundwater and water systems, deforestation, impacts on wildlife, etc. We collect biodiversity events for the firms with headquarters in the Group of Twenty, G20, where each respective stock exchange located within each country is found to be at a substantial level of market capitalisation and liquidity, thereby allowing for direct comparison without market-based differentials. In total, 980 valid International Securities Identification Numbers (ISIN) are identified from the RepRisk database, representing 3,555 distinct biodiversity issues for the period between 1 January 2007 and 31 December 2022. Then, data relating to the share prices of each investigated firm is obtained for the period between 1 January 2006 and 31 December 2023 to analyse the impact before and after the events. This procedure leaves us with 795 ISINs and 2,796 biodiversity events in the sample period.

The timeline of the growth of RepRisk-identified biodiversity events during the sample period analysed between 2007 and 2022 is presented in Figure 1. Primarily, we observe an overall upward trend in the cumulative number of events, as depicted by the relatively smooth trajectory, suggesting a growing prevalence or recognition of such events over time. Concurrently, the bar graph that is simultaneously presented indicates the monthly event frequency, demonstrating significant variability month-to-month. Notably, several outlier months exist, particularly since 2015, when the frequency of events has elevated dramatically. It must be noted that this could imply an actual increase in event occurrences, perhaps reflecting an enhancement in the media and social media reporting mechanisms. The variability suggests that while the propensity for biodiversity-related reputational events has increased over time, they occur sporadically rather than following a predictable pattern. The data could reflect evolving societal values, regulatory environments, and global awareness of biodiversity issues, which have become increasingly salient in corporate governance and sustainability discourses.

3.2. Methodology

As it is one of the basic assumptions of the finance theory, a firm's stock prices reflect all the available information about the firm in its stock prices. Given this assumption, we employ the event study methodology to quantify the impact of ESG-related news on the firm's financial performance. In particular, we investigate whether there are significant abnormal returns around the arrival of the ESG news. We employ multiple event windows to capture the delayed market response to the ESG-related news. More specifically, the event window ranges from sixty days before the event indicated by (-60,-1) to sixty days after indicated by $(t_0, +60)$ where t_0 is the event day. To calculate the (cumulative) abnormal return within the specified event window, we first need to determine the estimation model and the estimation window. An estimation model is necessary to compute the expected returns, which are the returns that would have been realized if the analysed event had not taken place. The abnormal returns are found by subtracting the expected returns (hypothetical returns) from the actual returns, which are the empirically observed returns. Both statistical and economic expected return models have been extensively used in the finance literature. A market model, or more specifically a comparison period mean adjusted model, along with both a market model with Scholes-Williams beta estimation and a market model with GARCH and EGARCH error estimation, can be listed among the statistical models. Fama-French factor models can be grouped under the economic models. In this research, we utilize the market model, one of the most widely used models in the literature. The market model assumes that the return follows a single-factor market model for each stock.

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \epsilon_{i,t}, \tag{1}$$

where $R_{m,t}$ is the return of the reference market on day t, $\epsilon_{i,t}$ is the innovation term with an expected mean value equal to zero, and $R_{i,t}$ stands for the return in period t on stock i. The regression coefficient β_i is a measure of the sensitivity of $R_{i,t}$ with respect to the reference market. We estimate the model parameters α_i and β_i in Eq. 1 for each stock i, using an ordinary least squares (OLS) regression framework within the estimation window. Although there is no standard rule to define the length of the estimation window in the literature, the convention is generally to take the last 252 days before the estimation window. Furthermore, the estimation window and the event window do not coincide to ensure that the estimated expected return is not affected by the event returns. We also follow the standard approach by using 252 business days before the event window. We do not consider the news if the price data for that stock is not available or not complete for the whole period of 252 days before the news day. Moreover, we also include a hold-out window of six days between the event window and the estimation window to eliminate the potential information flow between the specified periods. Once we established the expected return model estimation and event windows, we can calculate the abnormal returns by using the following formula:

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{m,t}), \tag{2}$$

where $AR_{i,t}$ denotes the abnormal return for stock i at time t, $\alpha_i + \beta_i$ are the estimated parameters from the estimation window using the market model. We use daily logarithmic returns, calculated as the logarithmic difference of the daily closing prices. We also aggregate the abnormal returns within the event window, defined as each event's cumulative abnormal return (CAR). Because of the uncertainty of the exact time that the news information flows into the market, CAR is an important statistic to fully analyse the event's effect on the stock prices. The following formula calculates the CAR for each news:

$$CAR_i = \sum_{t=T_1+h}^{T_2} AR_{i,t}, \tag{3}$$

where h is the holdout period in terms of days, $T_1 + h$ is the initial day, and T_2 is the last day of the event window. It is well-documented in the literature that the standard tests to measure the effect of a specific event on stock prices must be modified due to the presence of heteroskedasticity [Engle, 1982, Bollerslev, 1986]. Therefore, we consider various options within the Generalised Autoregressive Conditional Heteroskedastic (GARCH) family models best to understand the influence of cyberattacks and privacy violation events. We employ an exponential generalized autoregressive conditional heteroscedasticity (EGARCH) model developed by Nelson [1991] to specify the conditional variance (h_t) of the innovations. EGARCH exploits information contained in realised volatility measures while providing a flexible leverage function that accounts for return-volatility dependence. The EGARCH model has the advantage of ensuring the positivity of estimated conditional variance without any parameter restrictions, in contrast to the alternative GARCH specifications. It also imposes fewer parameter restrictions to guarantee the stationarity of the conditional variance. We focus specifically on both the return and volatility of each company through the use of EGARCH(1,1), EGARCH(1,2), EGARCH(2,1), and EGARCH(2,2) models for each event separately. We choose the best model depending on the Bayesian Information Criteria. In particular, we utilise the mean equation of the EGARCH(1,1) methodology as displayed in Equation (4).

$$r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_3 d_t + \varepsilon_t, \tag{4}$$

while we express the variance equation of our EGARCH(1,1) model as follows:

$$\ln(h_t^2) = \omega + \alpha\varepsilon_{t-1} + \gamma(|\varepsilon_{t-1}| - E(|\varepsilon_{t-1}|)) + \beta \ln(h_{t-1}^2). \tag{5}$$

We include an additional d_t term in Equation (4) in our analysis to provide a coefficient relating to the observed return differential for each of our investigated impacts on landscapes, ecosystems, and biodiversity events. The volatility sourced within shocks incorporated in the returns of traditional financial markets is therefore considered in the volatility estimation of the selected structure. Equation (4), r_{t-1} and r_{t-2} represent the lagged values of the observed corporate returns, while I_t represents the returns of the respective international benchmark index upon which the stock is traded and represents the interaction between the selected company returns and the corresponding domestic market index. To adequately and robustly assess the time period surrounding each event, we measure abnormal returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60], to test the pricing response both before and after the dates on which significant reputational events are found to occur as per **???**. Multiple other variations of analysis windows were considered; however, for the brevity of the presentation, only those listed above were included. Each number refers to the specific trading days relative to each identified event. Specifically, the periods [0,+20] and [0,+60] reflect return differentials for the periods one and three months after each identified event, reflecting the persistence of both returns and volatility in the aftermath of each event. Methodological structures are then repeated based on the characteristics being analysed as to whether the results have been influenced by incident severity, reach, novelty, or whether the event is directly (sharp) or indirectly (unsharp) related to each company. Further testing is conducted based on the year and geographical region in which the analysed event occurred. In total, 100,656 EGARCH methodologies are analysed, considering nine windows of analysis surrounding the 2,796 analysed events and the multiple robustness procedures considered through placebo tests.

To provide additional methodological robustness, testing procedures are again considered using the same identified companies and methodological structure. However, the windows analysed are re-considered when progressing three, six, nine, and twelve months into the future for a group known as the placebo group hereafter.[1]

To provide additional explanatory value, the presented return differentials resulting from the RepRisk-defined impacts on landscapes, ecosystems, and biodiversity are then considered in a methodology that encapsulates several distinct corporate characteristics. Each selected variable has been considered for various reasons, primarily surrounding the many industrial and sectoral pressures that exist, to identify whether deteriorating financial performance can be observed as an explanatory factor when considering the financial market response to such significant breaches. The data considered include Revenue Surprise[2], the natural logarithm of company market capitalisation, the Credit Combined Global Rank[3], the twelve-month Volatility Rank[4], and finally, the Credit Structural Asset Volatility Global Rank[5]. We consider the result surrounding the event window $[t_0,+1]$ to test whether corporate characteristics can explain whether such differential stock market response diminishes or perhaps persists in varying manners due to corporate factors.[6]

4. Results

Results based on our presented EGARCH of corporate events related to biodiversity analyses are separated and compared based on specific return and volatility behaviour. Table 1 presents evidence of the market's reaction to environmental concerns associated with corporate operations. For returns relating to the primary group, the results indicate a progressive increase in significant positive outcomes from the pre-event window of [-60,-1] through to the post-event window of $[t_0,+1]$, followed by a gradual decrease as the time after the event extends. The largest proportion of

[1]Due to the large number of additional results generated through this additional robustness testing procedure, only those results focusing on the six-month window are considered hereafter for the brevity of presentation. All other results pertaining to these additional robustness testing procedures are available from the authors upon request.

[2]Each of these variables is estimated as the difference between the actual value and the mean analyst estimate expressed as a percentage (as obtained from StarMine SmartEstimates through the Thomson Reuters DataStream data package).

[3]The variables represent the current global level 1 through 100 percentile rank respectively of a company's 1-year default probability based on the StarMine Combined Credit Risk Model, which blends the Structural, SmartRatios and Text Mining Credit Risk models into one final estimate of credit risk at the company level. Higher scores indicate companies that are less likely to go bankrupt or default on their debt obligations within the next 1-year period.

[4]Estimated as the current 1 through 100 percentile rank of the security versus all other securities on trailing twelve-month volatility.

[5]Estimated as the current global 1 through 100 ranks of the annualised volatility of the market value of the firm's assets according to the Structural Credit Risk Model. Firms with higher values of asset volatility are more likely to cross their default point (hence perceived to be more risky) and receive lower rank values.

[6]All examined windows of analysis were considered in this secondary analysis; however, for the brevity of presentation, only event window $[t_0,+1]$ are presented. All other results are available from the authors upon request.

significant positive outcomes (26.3%) occurs on the event day, suggesting a heightened sensitivity of returns to the event. Conversely, significant negative outcomes also rise, reaching a peak (29.8%) on the event day, indicating a substantial immediate negative market reaction, which declines over time. The estimated volatility differential reflects an increase in positive outcomes leading up to and peaking on the event day at 26.8%, suggesting that market volatility in response to these events is highest immediately after they occur. This heightened volatility stabilises somewhat in the longer post-event windows, although it remains significant. Such initial results highlight the market's nuanced response to biodiversity-related corporate events. The immediate period surrounding these events is characterised by increased market sensitivity, as reflected by the rise in both significant positive and negative outcomes. The market's reaction regarding returns and volatility is most pronounced in the event's immediate aftermath, which could reflect the market's assessment of the event's impact on the firm's prospects. As time progresses, this initial reaction tapers off, which may suggest a market correction or the absorption of the event's impact on the stock's price.

The concept of information asymmetry plays a pivotal role in understanding market reactions to new data. This initial phase of analysis is particularly evident in biodiversity-related corporate events, where the emergence of new information can lead to a significant reevaluation of a company's stock. According to the Efficient Market Hypothesis, market prices reflect all available information. Therefore, when novel information about a corporate event becomes public, it is rapidly assimilated into stock prices. The data presented reveals an elevation of significant outcomes—positive and negative alike—around the event day, underscoring the market's responsiveness to the unfolding scenario. This reactivity is characterised by an initial elevation in volatility, signifying a rapid reassessment of the firm's value as investors weigh the event's potential ramifications. Further, investor sentiment and behavioural biases are additional critical dimensions shaping market outcomes. Investors' responses to new information can diverge, influenced by their personal biases and sentiment, which are not always grounded in rationality. Corporate events also catalyse increased trading activity, drawing in speculators and arbitrageurs who aim to capitalise on the expected rise in market volatility. This speculative trading can amplify short-term market fluctuations, increasing trading volume and volatility as different market participants exploit the event-driven market dynamics.[7] The swift initial market response may also reflect a reassessment of risk, particularly

[7] Following the immediate market response, there is often a phase of market correction and information absorption. As further details emerge and investors understand the event's long-term implications, initial market overreactions are tempered, leading to a more stable and accurate valuation of the firm's prospects. This suggests that the market is integrating the new information and re-calibrating stock prices to reflect a revised narrative of the company's performance and valuation prospects.

in corporate governance and operational risk, factors that may not have been fully accounted for in the stock price before the event. Biodiversity-related events can expose previously undetected or undervalued vulnerabilities within a company's operations. Stock prices are adjusted to reflect this new risk profile as the market evaluates the potential impact on future earnings and the company's trajectory.

QQ-plots of returns in Figure 2 illustrate the abnormal return distributions of companies affected by biodiversity-related events, as estimated by an EGARCH model. These plots are essential for comparing the theoretical quantiles of a standard normal distribution against the empirical quantiles of the event-driven return differentials for the main test group and a placebo group across various pre-defined event windows. For the main test group, the plots indicate a clear deviation from the normal distribution in several windows surrounding the event. Specifically, in the period immediately preceding the event [-10,-1], there is a notable departure from the expected quantiles at the distribution's tails, suggesting that investors may have had anticipatory or potential information leakage manifesting in larger-than-expected return differentials. Additionally, the QQ-plot for the event day [t_0,+1] shows a pronounced skewness, likely reflecting the market's immediate reaction to the event, with potential overreaction manifesting as heavier tails. Conversely, the placebo group exhibits a closer adherence to the normal distribution, indicating that the events are specific to the RepRisk-defined dates, adding further robustness to our data and methodological selection, where biodiversity events have a tangible impact on the return dynamics of the firms in question, with abnormal returns becoming more pronounced as the event approaches and persists shortly thereafter. This reaction dissipates over time, as seen in the longer-term post-event windows, where the plots converge with the expected normal distribution. This convergence implies a market that corrects itself over time as it assimilates and reacts to new information. More broadly, these QQ-plots indicate a market sensitive to environmental information, responding asymmetrically around the occurrence of biodiversity-related corporate events. The observed patterns are consistent with the behaviour of semi-strong efficient markets, where prices adjust to new public information. However, heavy tails and asymmetries in the distribution of returns suggest that extreme movements in stock prices are not uncommon, reflecting the complex dynamics of investor psychology, information processing, and market adjustment mechanisms. These findings reinforce the notion that environmental concerns are important to financial markets and can drive considerable volatility in stock returns, underscoring the need for firms to manage their environmental impact.

The histograms depicted in Figure 3 compare the distribution of EGARCH-estimated return differentials for the main test group and the placebo group. In the main test group, the histograms exhibit significant deviations from the normal distribution, especially in windows closer to the event

([-10,-1] through [t_0, +1]), with return differentials displaying a leptokurtic distribution—indicative of fat tails and a peak higher than that of a normal distribution. This is consistent with outliers and suggests a strong investor reaction to the events, either in anticipation of or in response to new information released around the biodiversity incidents. The return distributions in the immediate post-event windows ([t_0,+1] and [t_0,+5]) show a pronounced skewness, with the tails of the distribution suggesting the occurrence of extreme returns more frequently than would be expected under a normal distribution. This skewness may reflect the market's reevaluation of the affected companies' future cash flows and risk profiles in response to the biodiversity events. The histograms for the placebo group do not exhibit the same level of pronounced skewness or kurtosis. This contrast suggests that the abnormal returns in the main test group are likely a direct consequence of the biodiversity events rather than a product of normal market volatility. The observed distributions provide further evidence of the significant impact of biodiversity-related events on stock returns, with the histograms capturing the marked departure from normality during the event period. These effects are transient, however, and tend to diminish over time as the market processes and integrates the new information. This again aligns with the semi-strong form of market efficiency, where prices adjust relatively quickly to public information, and the initial disturbance in return distributions is smoothed out as the market reaches a new equilibrium.[8]

Associated summary statistics for both the return and volatility estimates derived from EGARCH models are presented in Table 2 and Table 3 respectively, provide a more detailed portrayal of the market dynamics surrounding biodiversity events, informing us about the market's perception of risk and its reaction to unexpected environmental information. Results are presented as separated based on only those results significant at a level of at least 10% and based on the entire sample of estimates. In the primary group, the negative mean returns across most event windows reflect a market penalising firms for biodiversity-related incidents. The negative skewness before the event, transitioning to positive skewness immediately after, suggests that investors initially underestimated the impact of such events, leading to a rush to adjust positions as the event unfolds. The heightened kurtosis, particularly in the window immediately following the event [t_0,+1], indicates many outlier returns, consistent with a period of pronounced investor reaction to new information. Volatility statistics echo a similar sentiment, with mean volatility peaking on the event day [t_0,+1]. The elevated levels of kurtosis and skewness in this period suggest that the market was initially uncertain about how to value these biodiversity risks but then responded with heightened trading activity, possibly due to diverse interpretations among investors. Over time, the volatility begins

[8] Results relating to associated EGARCH-estimated volatility differentials as a result of biodiversity events exhibit similar behaviour and are presented in the associated Online Appendices in Figures A1 and A2.

to normalise as the event is absorbed into the market's collective understanding. This is evidenced by the decreasing variance, more moderate skewness, and kurtosis values in the longer post-event windows. Evidence suggests that biodiversity events have immediate and significant repercussions on affected firms' returns and volatility. However, the market appears efficient in processing this information, as indicated by the normalisation of this market behaviour over time.

The EGARCH-estimated coefficients are then modelled as separated by biodiversity event severity, sharpness, reach and novelty to further understand the impact of biodiversity events on stock returns and volatility. For returns, the results presented in Table 4 suggest that high-severity events have a relatively modest effect on stock returns, with some periods showing a positive relationship, although not always statistically significant. This could imply that while severe events are concerning, their actual impact on financial performance may be absorbed or diffused over time. In contrast, events characterised as sharp, or more specifically, when the entity is mentioned but the criticism is complex or potentially not precisely defined, result in significant deterioration of returns on the event date. Broad-reaching characteristics show mixed results, implying that events with wide-reaching consequences do not consistently affect stock returns in the short term. This may be due to the market's difficulty in immediately quantifying the implications of broad-reaching events. New issues representing novel events tend to have a more consistent negative impact, suggesting that the market is particularly averse to unfamiliar risks that are harder to assess and incorporate into stock prices.

Considering the volatility analysis presented in Table 5, high-severity events present elevated volatility, particularly in the shorter time windows surrounding the event. This is consistent with the idea that severe events induce uncertainty, leading to more volatile stock prices. No consistent pattern is identified when considering event sharpness; however, when considering broad-reaching events, the results are more consistent, indicating increased volatility, especially in the event's immediate aftermath. This increased volatility can be attributed to the market's attempt to assimilate the broad implications of such events. Finally, events denoted to be new issues significantly raise volatility across almost all time windows, highlighting the market's sensitivity to unprecedented events that defy existing pricing models and expectations.[9] This latter result is particularly interesting when considering that such elevated volatility for those corporations experiencing biodiversity events for the first time far outweighs that experienced by those experiencing repeated events. Therefore, it is possible that investors somewhat developed an "expectation" of

[9] Across models that consider both returns and volatility, the placebo group's coefficients are generally smaller and less significant, suggesting that the reactions observed in the primary group are indeed related to the biodiversity events and are not generated by random outcomes.

poor biodiversity-related behaviour for repeat offenders. Such biodiversity-related events introduce uncertainty through corporations with no previous track record that cannot be easily reconciled with established valuation models, prompting a reassessment of risk profiles. For companies with a history of biodiversity incidents, the market may have already adjusted to incorporate the associated risks into their valuations. However, the market experiences a shock for first-time offenders as the new information compels investors to update their expectations rapidly. This disparity in market reactions between new and repeated events may also reflect a learning curve among investors. Over time, those dealing with repeat offenders have developed a calibration for the expected impact of such events on stock prices, leading to a less dramatic response. In contrast, first-time events represent an unknown territory, demanding a more significant adjustment as investors digest potential long-term implications on the firm's value and reputation. Such findings align with and extend the narratives presented by Coqueret and Giroux [2023], Garel et al. [2023], and others by demonstrating the immediate and tangible market reactions to biodiversity-related information disclosures. This research supports the notion that markets increasingly value firms' environmental impacts, including their biodiversity footprints, and indicates a growing market premium for companies that proactively manage their biodiversity risks.

Such results are further verified visually using boxplots in Figure 4. The return differentials for the main group show a dispersion of estimates around the event date, signifying a market reaction to biodiversity events. The placebo group's uniform distribution suggests the absence of such events, confirming the efficacy of the control design. This contrast validates the significance of biodiversity events on market behaviour. Volatility differentials exhibit pronounced fluctuations for the main group at the event time, indicating a market reassessment of risk, whereas the placebo group remains comparatively stable. This heightened volatility underscores the market's sensitivity to new information concerning biodiversity, which is not captured in the placebo. The consistent pattern across the main group, as opposed to the controlled placebo group, accentuates the market's reaction to biodiversity events.[10]

Figure 5 illustrates the influence of event reach on the market's response to biodiversity events, where high-reach events, published in widely-read sources, demonstrate pronounced volatility and return differentials in the main group, suggesting that the extent of public exposure significantly affects market reactions. In contrast, despite being less publicised, low-reach events still provoke a discernible response, albeit less volatile. This implies that even limited exposure to biodiversity

[10] It is noteworthy that the differentials between the two groups, assumed to arise from model-specific factors, should not detract from the evident impact of biodiversity events. The market's response is thus not only immediate but also significant, reflecting the incorporation of environmental concerns into financial valuation.

risks can influence market perceptions, but the intensity of the reaction is correlated with the reach of the event's publication. The placebo group, serving as a temporal control, exhibits negligible differentials across both reach categories, reinforcing the idea that the observed fluctuations in the main group result from biodiversity events. The placebo group's stability further underscores the validity of the event study methodology.

Separation of results based on severity in Figure 6 presents evidence that high-severity events induce greater market volatility and return differentials in the main group, underscoring the market's acute sensitivity to severe incidents. This heightened response may reflect the market's anticipation of significant financial or reputational repercussions following grave violations. On the other hand, the lower-severity incidents elicit a more subdued market reaction, though still distinguishable from the placebo group, which shows minimal differentials. The modest response to lower-severity events suggests that while they are noted by the market, their expected impact on a firm's value is less pronounced.

The EGARCH-estimated return and volatility differentials in Figure 7, separated by the sharpness of biodiversity-related risk incidents, reveal distinct market responses. Sharp incidents, which feature well-defined and direct criticism, correspond with heightened volatility in the main group, reflecting a market quick to react to clear and specific reputational risks. Conversely, the response to unsharp incidents is less pronounced, suggesting that ambiguous or complex criticisms are not as immediately factored into market valuations. The placebo group, adjusted by 90 days, displays a muted pattern, emphasising that the observed market reactions are a consequence of the nature of risk incidents.

The presented EGARCH-estimated differentials in Figure 8 suggest that the novelty of biodiversity issues plays a crucial role in market reactions. Novel issues generate considerable volatility, as evidenced by the pronounced variance in the main group compared to the placebo. This heightened response may be attributed to the market's uncertainty and difficulty pricing new information lacking historical precedent. Conversely, returns do not exhibit a consistent pattern, indicating that the novelty of an event may primarily influence market uncertainty rather than directional price movements. The placebo group's stable profile further reinforces that the observed volatility directly results from the event's novelty. It is important to acknowledge that model differentials between the main and placebo groups exist but do not detract from the significance of novelty in market impact assessment.

The analysis of EGARCH-estimated responses to corporate reputational disasters, segregated by market capitalisation (M.Cap), yields nuanced insights into investor behaviour and market reactions. The results from Table 6, categorised by market capitalisation quintiles, suggest that the smallest firms, with M.Cap less than 0.2, exhibit the most statistically significant negative response at the [-20,-1] window, with a coefficient of -26 basis points (bp hereafter). This cohort also shows sustained negative returns post-event, with -32bp and -19bp at the [t_0,+5] and [t_0,+10] windows respectively, and a mild negative response at the [t_0,+60] window. The negative response in smaller firms could indicate their perceived vulnerability to reputational damage due to lower resilience and operational scale, which may not be as efficiently diversified against ESG risks as larger firms.

In stark contrast, larger firms, specifically those with M.Cap greater than or equal to 0.8, exhibit no significant response in any window, suggesting that market participants may view these entities as better positioned to absorb or deflect the impact of reputational disasters. The insignificance across all windows for the largest firms could imply a degree of investor confidence in these firms' ability to manage reputational risks, perhaps due to stronger governance frameworks or more substantial resources to mitigate the fallout from such events.

Separating investor reactions to biodiversity-related events by CSR Strategy Scores, as depicted in Table 7, where firms with the highest CSR scores (CSR >= 0.8) show a statistically significant negative response immediately before the event ([-60,-1] window), with an estimate of -21bps, and continued negative significance post-event at the [t_0,+5] and [t_0,+10] windows, suggesting that investors hold high-CSR firms to a higher standard of ESG compliance, reacting negatively when these firms fail to meet those standards. Conversely, firms with CSR scores below 0.8 exhibit a mix of insignificant and mildly negative responses, with those in the 0.6 to 0.8 range showing a significant negative response at the [-20,-1] window. It can be inferred that firms with mid-range CSR scores are penalised for reputational disasters, albeit not to the extent of their higher-scoring counterparts.

Table 8 integrates various corporate characteristics to identify their explanatory value based on the stock market's differential response to biodiversity-related reputational events. The model highlights the Global Credit Rank as a significant predictor at the [t_0,+1] window, with a coefficient of -58 bps, suggesting that firms with lower credit rankings are penalised more heavily by the market following a reputational event. Interestingly, no significant differential response was observed when considering the volatility measures (Vol12m), indicating that past stock volatility does not necessarily impact how the market prices in new information pertaining to reputational damage. These findings emphasise the complex interplay between firm size, CSR commitment, and creditworthiness in shaping investor reactions to ESG-related incidents. Results present evidence of a market that considers not only the event's nature but also the perceived ability of a firm to navigate the reputational challenge. The differential response predicated on these corporate characteristics offers novel evidence surrounding the market's nuanced risk evaluation in the context of

ESG concerns relating to biodiversity.

5. Discussion, Policy Implications, and Directions for Future Research

The findings from our analysis underscore the heightened market sensitivity to biodiversity-related corporate events, revealing a complex interplay between environmental considerations and financial performance. This sensitivity reflects investors' increased awareness and valuation of environmental factors. It suggests a growing recognition of these events' implications on corporate reputation and, ultimately, on stock returns and volatility. The immediate and significant market reactions to biodiversity events, characterised by both positive and negative outcomes, point to the necessity for robust corporate governance and sustainability practices. These practices not only serve to mitigate potential negative impacts but also enhance investor confidence and corporate resilience in the face of environmental challenges.

The role of information asymmetry in driving market reactions to biodiversity-related events raises substantial questions about market efficiency. Our findings indicate that markets quickly incorporate new environmental information into stock prices. Yet, the initial volatility suggests a period of adjustment where the market seeks to understand the implications of these events fully. This dynamic underscores the importance of transparent and timely disclosure practices, enabling investors to make informed decisions and ensuring that market prices accurately reflect available information. Furthermore, the influence of investor behaviour and psychological factors, such as sentiment and behavioural biases, on market reactions highlights the potential for misinformation to exacerbate market volatility. In this context, the emergence of false rumours or fake news presents an additional corporate threat, potentially leading to unwarranted market disturbances. The rapid dissemination of information through social media and other digital platforms can amplify these effects, making it imperative for corporations and regulatory bodies to manage and counteract misinformation actively. Corporate governance and sustainability practices emerge as critical tools in this landscape. Firms with robust environmental strategies and transparent reporting mechanisms will likely fare better in mitigating the negative impacts of biodiversity events and misinformation.

The policy implications derived from our comprehensive analysis are profound, urging a reevaluation of current regulatory frameworks to ensure they adequately address the complexities introduced by environmental considerations in financial markets. Specifically, our findings advocate for the implementation of enhanced disclosure mandates that compel firms to report not only on their direct environmental impacts but also on their strategies for managing biodiversity risks. Such disclosure requirements would need to extend beyond traditional financial reporting to include detailed ESG metrics, thereby providing investors with a holistic view of a firm's environmental stewardship and potential exposure to biodiversity-related risks. Moreover, the volatility observed in market responses to biodiversity-related corporate events highlights the urgent need for regulatory standards to curb misinformation. This entails establishing stringent verification processes for environmental claims and promptly correcting unfounded rumours or deliberately misleading information.

Several avenues for future research are identified, including examining long-term impacts and sector-specific responses to understand the persistence and differential sensitivity across industries. Cross-country comparisons could further identify specific factors surrounding the influence of varied regulatory and cultural contexts on market behaviour. Investigating the role of information asymmetry and the efficiency of market reactions, alongside the interplay between corporate governance, sustainability practices, and investor perceptions, offers strong ground for further study. Additionally, incorporating behavioural finance perspectives could better identify the psychological underpinnings of investor responses. The advent of technology and social media in shaping and disseminating information presents another key area of future research, as does a more granular investigation based on the type and severity of biodiversity events through comparative analyses. Lastly, exploring our findings' policy and strategic corporate implications could contribute to more resilient and sustainable corporate practice.

6. Concluding Comments

This research thoroughly examines the market's response to biodiversity-related corporate events through the application of EGARCH models developing upon a novel dataset, uncovering a sensitive landscape where environmental issues significantly impact financial performance and investor behaviour. We have identified a significantly elevated trend in market response to such events, indicating an increasing recognition of environmental issues in corporate financial valuation. This sensitivity is characterised by pronounced market reactions, both positive and negative, surrounding the formal media announcement of corporate biodiversity events, underscoring the financial relevance of biodiversity risks and highlighting the evolving dynamics of investor perceptions and market efficiency in the face of environmental information.

Focusing on the role of information asymmetry and market efficiency in biodiversity-related corporate events, our research underscores the intricacies of how markets process environmental information. The swift integration of such information into stock prices, albeit accompanied by initial volatility, illustrates the market's capability to adapt to new data, aligning with the principles of semi-strong market efficiency. This phenomenon underscores a critical observation: markets are responsive to the revelation of environmental risks, yet the complexity and novelty of these risks necessitate a period of adjustment. This adjustment phase highlights the importance of transparency in corporate disclosures. Enhanced disclosure practices, which offer comprehensive insights into a firm's environmental risks and management strategies, are essential for mitigating the informational asymmetry that can exacerbate market volatility. Moreover, our analysis sheds light on the discerning nature of investor responses to biodiversity events, which are significantly influenced by the specific characteristics of these incidents. The market's differential reaction to the novelty and severity of biodiversity-related risks reveals a sophisticated investor calculus that goes beyond generic risk assessment. Investors employ a nuanced valuation approach, particularly when faced with novel or severe environmental incidents. This differentiation by investors indicates a depth of market analysis where the perceived impact of an event on a firm's long-term sustainability and operational integrity informs investment decisions, where such discernment suggests that markets are moving towards a more refined understanding of environmental risks, recognising the varied implications these risks can have on corporate performance and valuation.

References

Akyildirim, E., S. Corbet, A. Sensoy, and L. Yarovaya (2020). The impact of blockchain related name changes on corporate performance. *Journal of Corporate Finance 65*, 101759.

Anthony, S. and A. Morrison-Saunders (2023). Analysing corporate forest disclosure: How does business value biodiversity? *Business Strategy and the Environment 32*(1), 624–638.

Ardia, D., K. Bluteau, K. Boudt, and K. Inghelbrecht (2023). Climate change concerns and the performance of green vs. brown stocks. *Management Science 69*(12), 7607–7632.

Bansal, P. and K. Roth (2000). Why companies go green: A model of ecological responsiveness. *Academy of management journal 43*(4), 717–736.

Boiral, O. (2016). Accounting for the unaccountable: Biodiversity reporting and impression management. *Journal of Business Ethics 135*(4), 751–768.

Boiral, O. and I. Heras-Saizarbitoria (2017). Managing Biodiversity Through Stakeholder Involvement: Why, Who, and for What Initiatives? *Journal of Business Ethics 140*(3), 403–421.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics 31*(3), 307–327.

Bolton, P. and M. Kacperczyk (2021). Do investors care about carbon risk? *Journal of financial economics 142*(2), 517–549.

Bolton, P. and M. Kacperczyk (2023). Global pricing of carbon-transition risk. *The Journal of Finance 78*(6), 3677–3754.

Coqueret, G. and T. Giroux (2023). A Closer Look at the Biodiversity Premium. *Available at SSRN 4489550*.

De Angelis, T., P. Tankov, and O. D. Zerbib (2023). Climate impact investing. *Management Science 69*(12), 7669–7692.

Di Giuli, A. and L. Kostovetsky (2014). Are red or blue companies more likely to go green? Politics and corporate social responsibility. *Journal of financial economics 111*(1), 158–180.

D'Amato, D., M. Wan, N. Li, M. Rekola, and A. Toppinen (2018). Managerial Views of Corporate Impacts and Dependencies on Ecosystem Services: A Case of International and Domestic Forestry Companies in China. *Journal of Business Ethics 150*(4), 1011–1028.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of united kingdom inflation. *Econometrica: Journal of the Econometric Society*, 987–1007.

Escobar, L. and H. Vredenburg (2011). Multinational Oil Companies and the Adoption of Sustainable Development: A Resource-Based and Institutional Theory Interpretation of Adoption Heterogeneity. *Journal of Business Ethics 98*(1), 39–65.

Flammer, C., T. Giroux, and G. Heal (2023). Biodiversity finance. Technical report, National Bureau of Economic Research.

Garel, A., A. Romec, Z. Sautner, and A. F. Wagner (2023). Do Investors Care About Biodiversity? *Swiss Finance Institute Research Paper* (23-24).

Hsu, P.-h., K. Li, and C.-y. Tsou (2023). The pollution premium. *The Journal of Finance 78*(3), 1343–1392.

Kang, K. (2016). Policy influence and private returns from lobbying in the energy sector. *The Review of Economic Studies 83*(1), 269–305.

Karolyi, G. A. and J. Tobin-de la Puente (2023). Biodiversity finance: A call for research into financing nature. *Financial Management*.

Leippold, M., Z. Sautner, and T. Yu (2024). Corporate Climate Lobbying. *Available at SSRN 4711812*.

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the Econometric Society*, 347–370.

Pástor, L., R. F. Stambaugh, and L. A. Taylor (2021). Sustainable investing in equilibrium. *Journal of Financial Economics 142*(2), 550–571.

Pedersen, L. H., S. Fitzgibbons, and L. Pomorski (2021). Responsible investing: The ESG-efficient frontier. *Journal of Financial Economics 142*(2), 572–597.

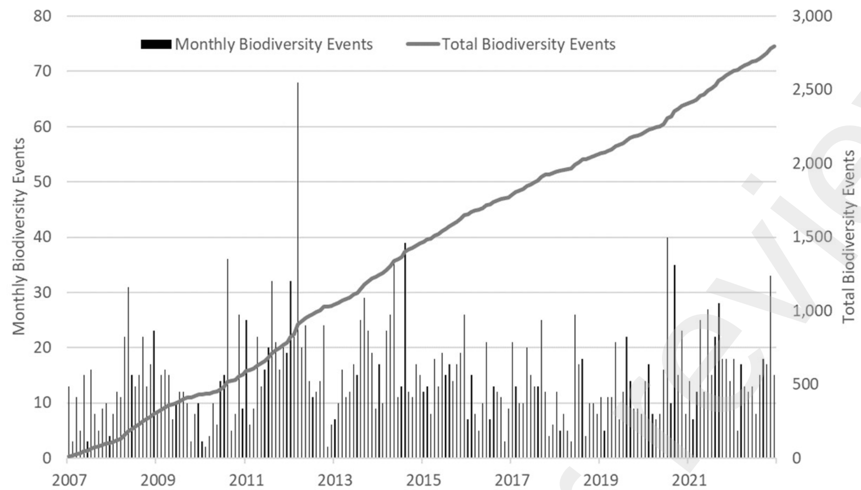
Schimanski, T., C. C. Senni, G. Gostlow, J. Ni, T. Yu, and M. Leippold (2023). Exploring Nature: Datasets and Models for Analyzing Nature-Related Disclosures. *arXiv preprint arXiv:2312.17337*.

Van der Beck, P. (2021). Flow-driven ESG returns. *Swiss Finance Institute Research Paper* (21-71).

Zeng, L., W.-K. Wong, H. Fu, H. Mahmoud, P. Cong, D. Thuy, and P. Bach (2024). FinTech and sustainable financing for low carbon energy transitions: A biodiversity and natural resource perspective in BRICS economies. *Resources Policy 88*, 104486.

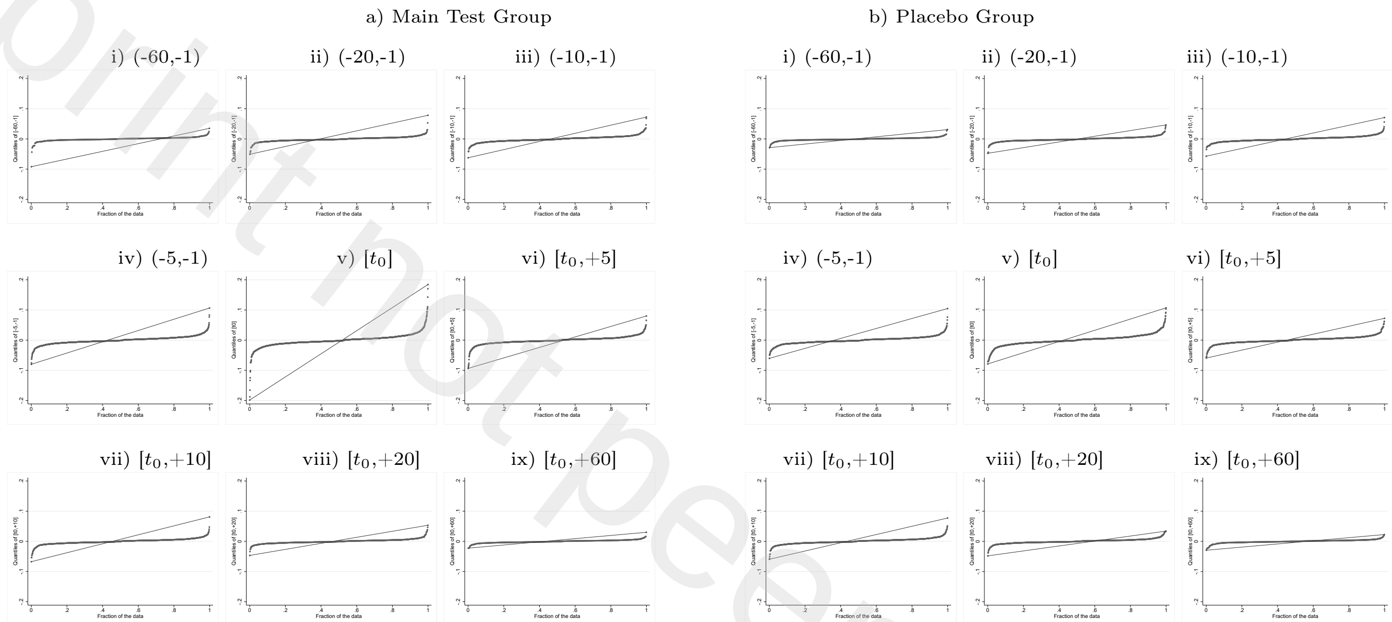
Zhang, S. (2023). Carbon Returns Across the Globe. *Available at SSRN 4378464*.

Figure 1: Frequency of Biodiversity Events



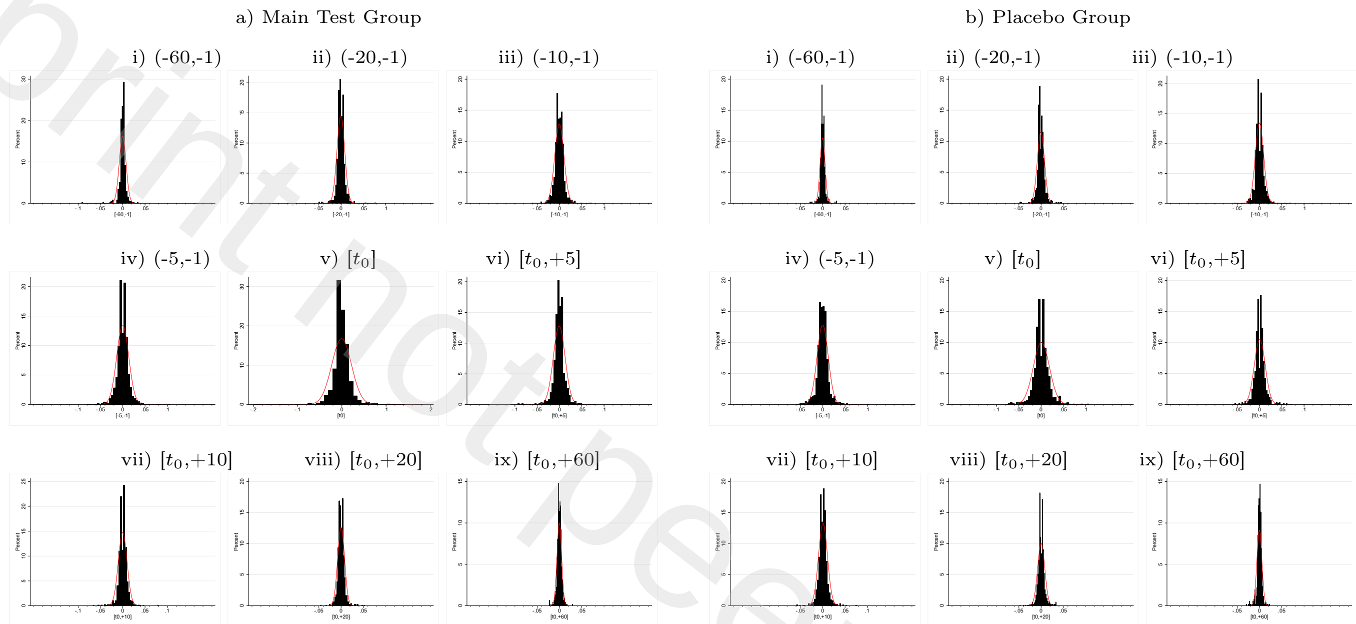
Note: We collect biodiversity events for the firms with headquarters in the Group of Twenty (G20), where each respective stock exchange located within each country is found to be at a substantial level of market capitalisation and liquidity, thereby allowing for direct comparison without market-based differentials. In total, 980 valid International Securities Identification Numbers (ISIN) were identified from the RepRisk database as having biodiversity issues between 1 January 2007 and 31 December 2022, as presented in the above Figure.

Figure 2: QQ-plots of EGARCH-Estimated Return Differentials as a Result of Biodiversity Events



Note: The above figures represent QQ plots based on the abnormal return response of each company as a result of 3,555 biodiversity events as identified using the RepRisk database. To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], $[t_0,+1]$, $[t_0,+5]$, $[t_0,+10]$, $[t_0,+20]$, and $[t_0,+60]$ to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Figure 3: Histograms of EGARCH-Estimated Return Differentials as a Result of Biodiversity Events

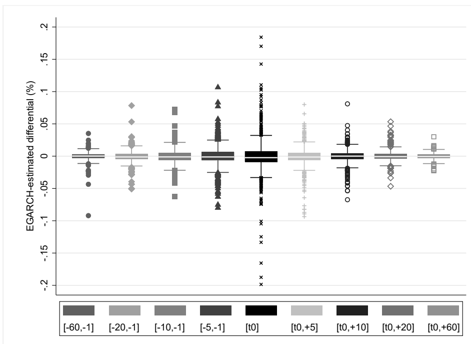


Note: The above figures represent histograms based on the abnormal return response of each company as a result of 3,555 biodiversity events as identified using the RepRisk database. To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

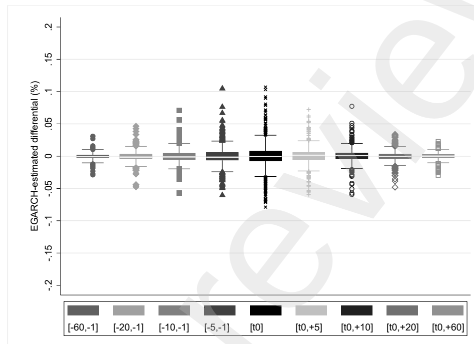
Figure 4: EGARCH-Estimated Return and Volatility Differential due to Biodiversity Events

(a) EGARCH-Estimated Return Differential

i) Main Group

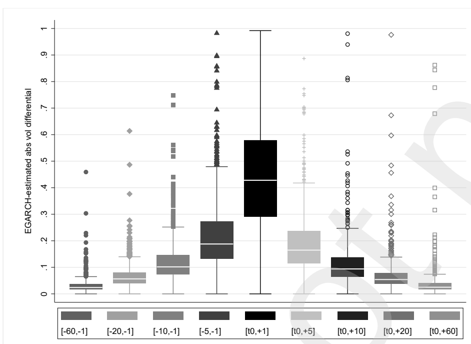


ii) Placebo Group

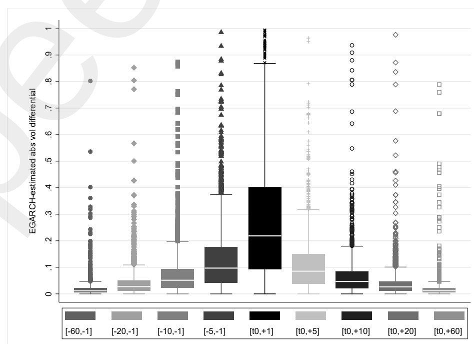


(b) EGARCH-Estimated Volatility Differential

i) Main Group



ii) Placebo Group



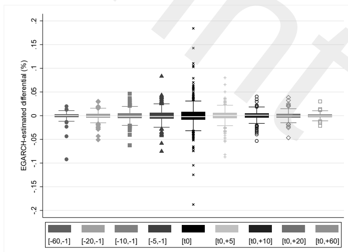
Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Figure 5: Reach-Separated EGARCH-Estimated Return and Volatility Differential due to Biodiversity Events

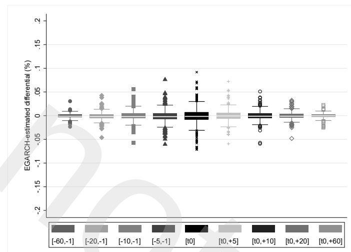
(a) **High Reach**

Returns

i) Main Group

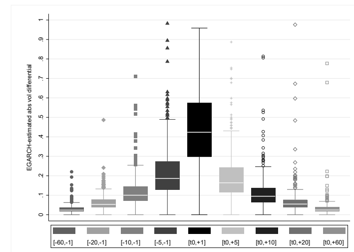


ii) Placebo Group

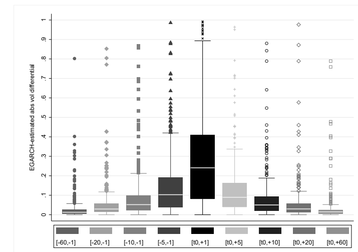


Volatility

i) Main Group



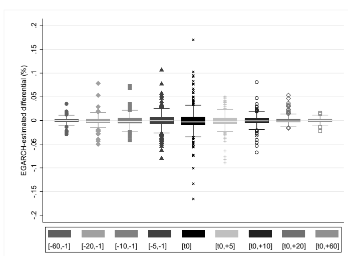
ii) Placebo Group



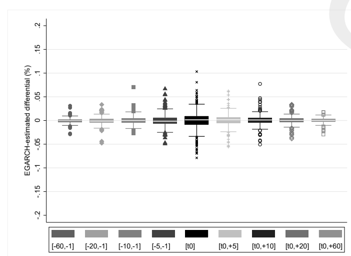
(b) **Low Reach**

Returns

i) Main Group

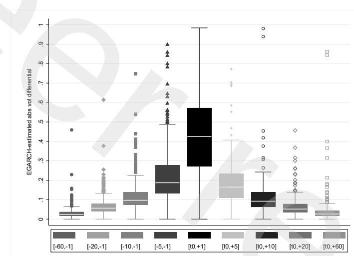


ii) Placebo Group

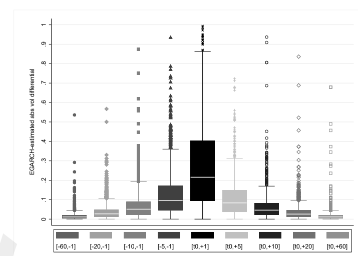


Volatility

i) Main Group



ii) Placebo Group



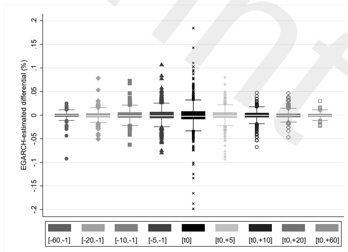
Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Figure 6: Severity-Separated EGARCH-Estimated Return and Volatility Differential due to Biodiversity Events

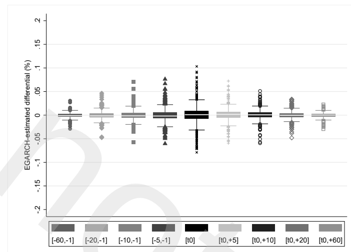
(a) **High Severity**

Returns

i) Main Group

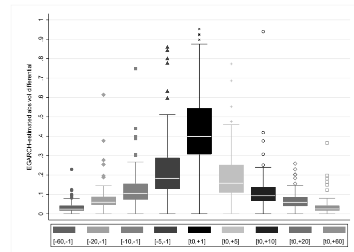


ii) Placebo Group

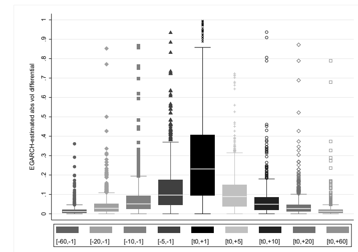


Volatility

i) Main Group



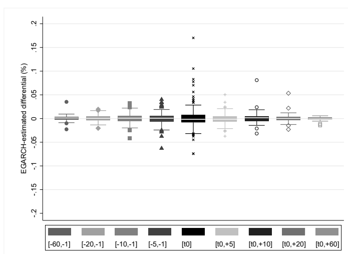
ii) Placebo Group



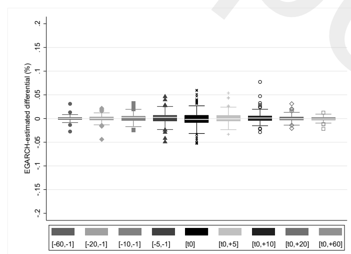
(b) **Low Severity**

Returns

i) Main Group

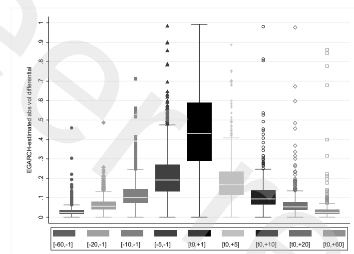


ii) Placebo Group

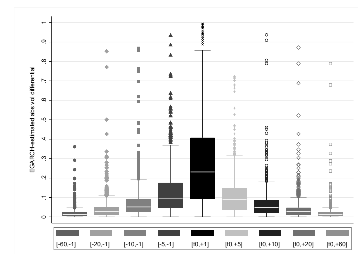


Volatility

i) Main Group



ii) Placebo Group



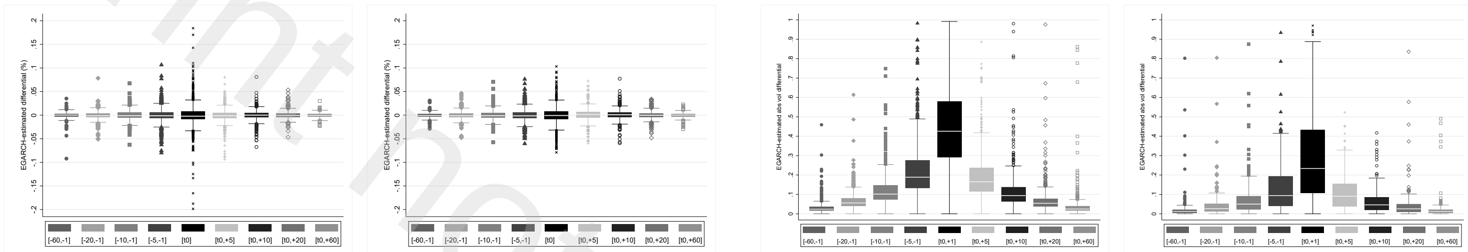
Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Figure 7: Sharpness-Separated EGARCH-Estimated Return and Volatility Differential due to Biodiversity Events

(a) **Sharp Event**

Returns — i) Main Group, ii) Placebo Group

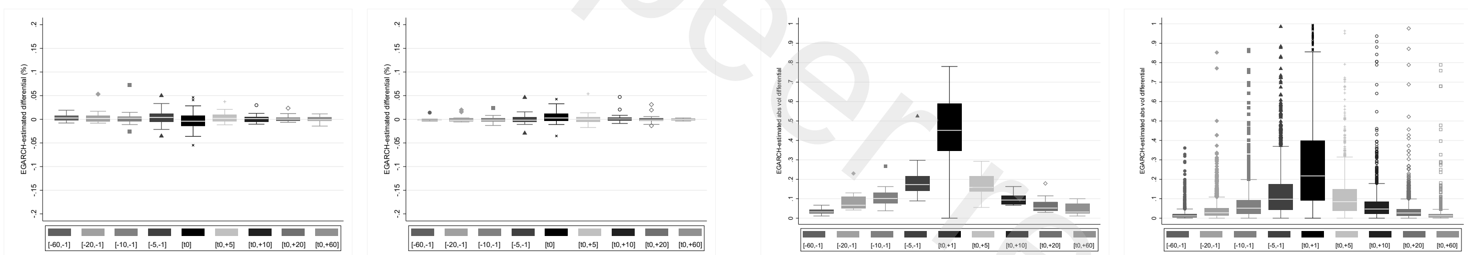
Volatility — i) Main Group, ii) Placebo Group



(b) **Unsharp Event**

Returns — i) Main Group, ii) Placebo Group

Volatility — i) Main Group, ii) Placebo Group



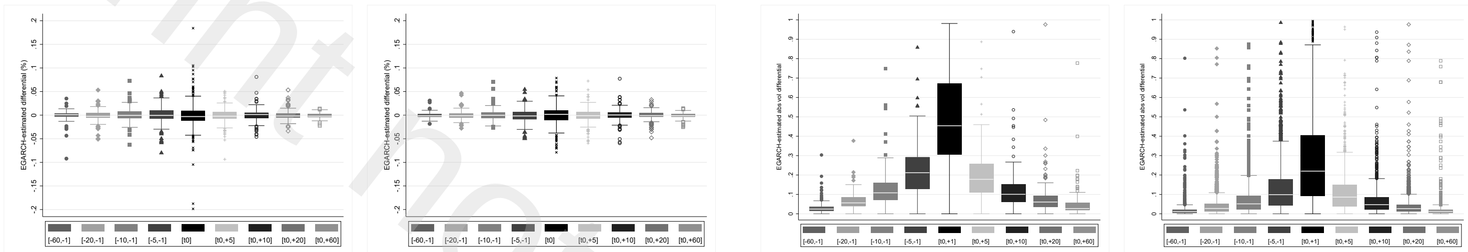
Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Figure 8: Novelty-Separated EGARCH-Estimated Return and Volatility Differential due to Biodiversity Events

(a) **Novel Event**

Returns — i) Main Group, ii) Placebo Group

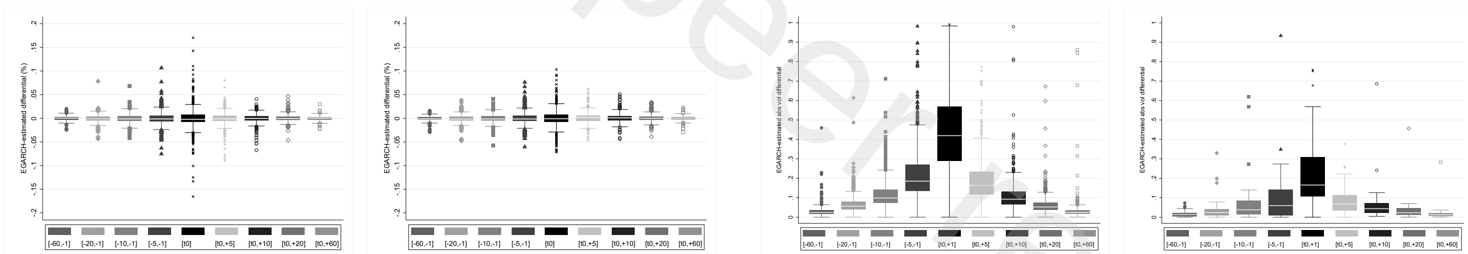
Volatility — i) Main Group, ii) Placebo Group



(b) **Repeated Event**

Returns — i) Main Group, ii) Placebo Group

Volatility — i) Main Group, ii) Placebo Group



Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Table 1: Proportion of Significant EGARCH-Estimated Outcomes per Analysed Window of Investigation

	[-60,-1]	[-20,-1]	[-10,-1]	[-5,-1]	[t_0 ,+1]	[t_0 ,+5]	[t_0 ,+10]	[t_0 ,+20]	[t_0 ,+60]
					Return Differential				
Positive Outcomes	232	368	510	628	730	610	513	370	212
	8.4%	13.3%	18.4%	22.6%	26.3%	22.0%	18.5%	13.3%	7.6%
Negative Outcomes	223	443	561	665	826	651	508	398	233
	8.0%	16.0%	20.2%	24.0%	29.8%	23.5%	18.3%	14.3%	8.4%
					Volatility Differential - Absolute Measure				
Positive Outcomes	404	611	715	752	750	726	707	619	435
	14.4%	21.9%	25.6%	26.9%	26.8%	26.0%	25.3%	22.1%	15.6%

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and further accompanying placebo tests have been omitted; however, they are available from the authors upon request.

Table 2: EGARCH-estimated Return Statistics due to Biodiversity-Related Corporate Reputational Events

					Percentile					
Window	Mean	Var	Skew	Kurt	1%	5%	10%	90%	95%	99%
				Descriptive Statistics for Significant Dummy Coefficients						
(-60,-1)	-0.0003	0.0001	-4.2503	51.76	-0.0236	-0.0093	-0.0058	0.0053	0.0087	0.0157
(-20,-1)	-0.0006	0.0001	0.3977	17.71	-0.0275	-0.0117	-0.0086	0.0074	0.0113	0.0196
(-10,-1)	-0.0002	0.0001	0.4648	9.71	-0.0270	-0.0146	-0.0106	0.0097	0.0139	0.0304
(-5,-1)	-0.0004	0.0003	-6.3596	138.43	-0.0411	-0.0198	-0.0137	0.0131	0.0196	0.0372
(t_0 ,+1)	-0.0003	0.0005	1.0142	32.10	-0.0556	-0.0289	-0.0186	0.0179	0.0281	0.0730
(t_0 ,+5)	-0.0006	0.0002	-1.0173	13.65	-0.0399	-0.0182	-0.0123	0.0123	0.0175	0.0364
(t_0 ,+10)	-0.0002	0.0001	-0.3116	13.84	-0.0318	-0.0125	-0.0088	0.0092	0.0134	0.0237
(t_0 ,+20)	0.0000	0.0001	0.9587	12.18	-0.0182	-0.0101	-0.0072	0.0075	0.0108	0.0263
(t_0 ,+60)	-0.0003	0.0000	-0.0732	7.90	-0.0154	-0.0075	-0.0056	0.0049	0.0065	0.0129
				Descriptive Statistics for All Dummy Coefficients						
(-60,-1)	-0.0001	0.0000	-5.6025	120.17	-0.0104	-0.0049	-0.0032	0.0033	0.0049	0.0105
(-20,-1)	-0.0004	0.0001	-4.5700	115.54	-0.0206	-0.0090	-0.0058	0.0050	0.0083	0.0171
(-10,-1)	-0.0002	0.0001	-2.3823	70.04	-0.0228	-0.0121	-0.0079	0.0075	0.0107	0.0256
(-5,-1)	-0.0002	0.0002	-5.6826	160.43	-0.0377	-0.0173	-0.0105	0.0103	0.0163	0.0365
(t_0 ,+1)	0.0000	0.0005	1.6183	40.64	-0.0502	-0.0252	-0.0155	0.0152	0.0243	0.0640
(t_0 ,+5)	-0.0037	0.0251	-45.4137	2074.22	-0.0368	-0.0150	-0.0095	0.0088	0.0153	0.0309
(t_0 ,+10)	0.0000	0.0001	-0.1377	20.90	-0.0261	-0.0100	-0.0068	0.0064	0.0101	0.0218
(t_0 ,+20)	-0.0001	0.0000	0.7319	19.08	-0.0159	-0.0076	-0.0053	0.0046	0.0074	0.0168
(t_0 ,+60)	-0.0001	0.0000	-0.7829	25.72	-0.0105	-0.0048	-0.0030	0.0028	0.0044	0.0096

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Multiple variations of placebo testing results are committed for brevity of presentation and are available from the authors upon request.

Table 3: EGARCH-estimated Volatility Statistics due to Biodiversity-Related Corporate Reputational Events

					Percentile					
Window	Mean	Var	Skew	Kurt	1%	5%	10%	90%	95%	99%
Descriptive Statistics for Significant Dummy Coefficients										
(-60,-1)	0.0273	0.0386	25.8505	743.1463	0.0096	0.0114	0.0137	0.0722	0.1051	0.3011
(-20,-1)	0.0457	0.0211	18.6672	406.7077	0.0232	0.0274	0.0308	0.1222	0.1558	0.2749
(-10,-1)	0.0831	0.0590	17.7913	361.1273	0.0379	0.0510	0.0581	0.2056	0.2704	0.5586
(-5,-1)	0.1630	0.2155	14.2700	228.9717	0.0716	0.0949	0.1093	0.4085	0.5159	1.3293
(t_0 ,+1)	0.3834	1.1671	14.3746	237.6396	0.1625	0.2181	0.2582	0.9094	1.1959	9.1244
(t_0 ,+5)	0.1485	0.3496	19.8254	468.5955	0.0625	0.0761	0.0930	0.3504	0.4661	2.1383
(t_0 ,+10)	0.0962	0.3268	22.2908	577.2264	0.0385	0.0439	0.0501	0.2038	0.2487	0.8131
(t_0 ,+20)	0.0481	0.0447	24.8917	745.9899	0.0205	0.0250	0.0297	0.1196	0.1604	0.4790
(t_0 ,+60)	0.0416	0.2435	32.1134	1160.6652	0.0093	0.0122	0.0142	0.0738	0.1198	0.8210
Descriptive Statistics for All Dummy Coefficients										
(-60,-1)	0.0217	0.0038	17.6324	418.8280	0.0088	0.0119	0.0139	0.0728	0.1242	0.3558
(-20,-1)	0.0450	0.0144	20.5234	539.0452	0.0202	0.0259	0.0306	0.1233	0.1602	0.3253
(-10,-1)	0.0809	0.0398	17.3848	370.6476	0.0370	0.0473	0.0571	0.2279	0.2824	0.6853
(-5,-1)	0.1560	0.1328	14.3383	246.9145	0.0747	0.0929	0.1077	0.4212	0.5248	1.4105
(t_0 ,+1)	0.3851	0.8744	12.6721	186.8606	0.1832	0.2283	0.2686	0.9471	1.2080	2.9700
(t_0 ,+5)	0.1405	0.1513	14.3234	241.2960	0.0625	0.0829	0.0938	0.3270	0.4538	1.2072
(t_0 ,+10)	0.0866	0.1069	19.3990	469.8287	0.0371	0.0454	0.0530	0.2079	0.3179	1.0324
(t_0 ,+20)	0.0545	0.0675	20.1872	496.8163	0.0212	0.0258	0.0299	0.1395	0.2106	0.8779
(t_0 ,+60)	0.0313	0.0347	21.9114	591.6801	0.0092	0.0120	0.0140	0.0808	0.1722	1.4536

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Multiple variations of placebo testing results are committed for brevity of presentation and are available from the authors upon request.

Table 4: Biodiversity-Related Return Dynamics due to Event Characteristics

	[-60,-1]	[-20,-1]	[-10,-1]	[-5,-1]	[t_0 ,+1]	[t_0 ,+5]	[t_0 ,+10]	[t_0 ,+20]	[t_0 ,+60]
					Primary Group				
					OLS regression using significant dummy coefficients				
High Severity	0.0011	0.0011	0.0005	0.0001	0.0010	0.0005	0.0011	0.0006	0.0002
	(0.0007)	(0.0007)	(0.0008)	(0.0009)	(0.0012)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
Sharp	-0.0027	-0.0035*	-0.0015	-0.0049**	0.0034	-0.0042**	-0.0013	-0.0018	-0.0001
	(0.0020)	(0.0019)	(0.0020)	(0.0022)	(0.0033)	(0.0021)	(0.0017)	(0.0015)	(0.0014)
Broad Reaching	0.0008	0.0007	0.0006	0.0003	0.0005	0.0001	0.0001	-0.0006	-0.0005
	(0.0006)	(0.0005)	(0.0006)	(0.0007)	(0.0009)	(0.0007)	(0.0006)	(0.0005)	(0.0005)
New Issue	-0.0003	-0.0005	0.0013*	0.0008	-0.0001	-0.0004	-0.0005	-0.0003	-0.0012**
	(0.0006)	(0.0006)	(0.0007)	(0.0009)	(0.0011)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
					OLS regression using all estimated coefficients				
High Severity	0.0004**	0.0006*	0.0005	0.0005	0.0010	0.0005	0.0006	0.0002	0.0001
	(0.0002)	(0.0003)	(0.0004)	(0.0006)	(0.0009)	(0.0005)	(0.0004)	(0.0003)	(0.0002)
Sharp	-0.0006	-0.0013	-0.0010	-0.0036**	0.0012	-0.0029**	-0.0010	-0.0011	0.0001
	(0.0005)	(0.0009)	(0.0011)	(0.0016)	(0.0024)	(0.0015)	(0.0010)	(0.0008)	(0.0005)
Broad Reaching	0.0001	0.0002	0.0002	-0.0001	-0.0001	-0.0001	-0.0002	0.0001	-0.0001
	(0.0002)	(0.0003)	(0.0003)	(0.0005)	(0.0007)	(0.0004)	(0.0003)	(0.0002)	(0.0001)
New Issue	-0.0001	-0.0002	0.0004	0.0003	0.0002	-0.0001	-0.0001	-0.0002	-0.0002
	(0.0002)	(0.0003)	(0.0004)	(0.0006)	(0.0008)	(0.0005)	(0.0004)	(0.0003)	(0.0001)
					Placebo Group				
					OLS regression using significant dummy coefficients				
High Severity	0.0002	0.0007	0.0013*	0.0022**	-0.0007	-0.0001	0.0007	-0.0001	-0.0004
	(0.0006)	(0.0007)	(0.0007)	(0.0009)	(0.0012)	(0.0009)	(0.0008)	(0.0007)	(0.0006)
Sharp	-0.0004	-0.0009	0.0005	0.0001	-0.0044	-0.0002	-0.0019	-0.0010	0.0002
	(0.0015)	(0.0017)	(0.0016)	(0.0022)	(0.0029)	(0.0023)	(0.0020)	(0.0018)	(0.0017)
Broad Reaching	-0.0001	-0.0002	-0.0006	-0.0010	-0.0001	-0.0002	-0.0002	-0.0003	-0.0002
	(0.0005)	(0.0005)	(0.0005)	(0.0007)	(0.0009)	(0.0007)	(0.0006)	(0.0006)	(0.0005)
New Issue	-0.0003	0.0002	-0.0001	-0.0004	-0.0008	-0.0016 **	-0.0006	-0.0008	-0.0016***
	(0.0005)	(0.0006)	(0.0007)	(0.0008)	(0.0011)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
					OLS regression using all dummy coefficients				
High Severity	-0.0001	0.0006**	0.0008**	0.0014**	0.0001	0.0001	0.0003	-0.0001	-0.0001
	(0.0002)	(0.0003)	(0.0004)	(0.0006)	(0.0009)	(0.0006)	(0.0004)	(0.0003)	(0.0002)
Sharp	0.0001	-0.0005	0.0007	-0.0003	-0.0040*	-0.0008	-0.0006	-0.0003	-0.0005
	(0.0005)	(0.0008)	(0.0011)	(0.0016)	(0.0024)	(0.0015)	(0.0011)	(0.0008)	(0.0005)
Broad Reaching	0.0001	-0.0002	-0.0003	-0.0009**	-0.0001	0.0001	0.0001	-0.0001	-0.0001
	(0.0001)	(0.0002)	(0.0003)	(0.0004)	(0.0007)	(0.0004)	(0.0003)	(0.0002)	(0.0002)
New Issue	-0.0001	-0.0001	0.0001	-0.0002	-0.0003	-0.0010**	-0.0003	-0.0003	-0.0004**
	(0.0002)	(0.0003)	(0.0004)	(0.0005)	(0.0008)	(0.0005)	(0.0004)	(0.0003)	(0.0002)

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 5: Biodiversity-Related Volatility Dynamics due to Event Characteristics

	[-60,-1]	[-20,-1]	[-10,-1]	[-5,-1]	[t_0 ,+1]	[t_0 ,+5]	[t_0 ,+10]	[t_0 ,+20]	[t_0 ,+60]
Primary Group									
OLS regression using significant dummy coefficients									
High Severity	-0.0016	0.0089*	0.0126	0.0343*	-0.0055	-0.0039	0.0031	-0.0007	-0.0073
	(0.0054)	(0.0048)	(0.0082)	(0.0186)	(0.1251)	(0.0245)	(0.0101)	(0.0069)	(0.0135)
Sharp	0.0046	-0.0191	0.0168	0.0546	0.2057	0.0529	0.0234	0.0015	0.0079
	(0.0125)	(0.0120)	(0.0200)	(0.0453)	(0.3148)	(0.0697)	(0.0304)	(0.0205)	(0.0339)
Broad Reaching	-0.0072*	-0.0022	-0.0027	-0.0490***	-0.2209**	-0.0343*	-0.0058	0.0010	-0.0209**
	(0.0043)	(0.0037)	(0.0064)	(0.0149)	(0.0987)	(0.0197)	(0.0081)	(0.0053)	(0.0104)
New Issue	0.0133***	0.0067	0.0227***	0.0344**	0.3616***	0.0746***	0.0192**	0.0224***	0.0341***
	(0.0048)	(0.0042)	(0.0074)	(0.0175)	(0.1151)	(0.0229)	(0.0093)	(0.0060)	(0.0111)
OLS regression using all estimated coefficients									
High Severity	0.0018	0.0039*	0.0057	0.0149*	0.0227	0.0071	0.0032	0.0025	0.0012
	(0.0015)	(0.0023)	(0.0040)	(0.0078)	(0.0175)	(0.0068)	(0.0039)	(0.0025)	(0.0018)
Sharp	0.0008	-0.0112*	-0.0116	-0.0109	-0.0106	0.0083	0.0088	0.0064	-0.0004
	(0.0038)	(0.0061)	(0.0107)	(0.0211)	(0.0475)	(0.0185)	(0.0104)	(0.0065)	(0.0046)
Broad Reaching	-0.0014	-0.0026	-0.0025	-0.0072	-0.0133	-0.0038	-0.0021	-0.0023	-0.0024*
	(0.0011)	(0.0018)	(0.0031)	(0.0060)	(0.0136)	(0.0053)	(0.0030)	(0.0019)	(0.0014)
New Issue	0.0034***	0.0039*	0.0103***	0.0187***	0.0276*	0.0112*	0.0059*	0.0064***	0.0078***
	(0.0013)	(0.0021)	(0.0036)	(0.0071)	(0.0161)	(0.0062)	(0.0035)	(0.0022)	(0.0015)
Placebo Group									
OLS regression using significant dummy coefficients									
High Severity	0.0029	0.0005	-0.0020	-0.0029	-0.0496	-0.0243	-0.0162	0.0061	0.0200
	(0.0071)	(0.0057)	(0.0104)	(0.0176)	(0.0427)	(0.0165)	(0.0143)	(0.0136)	(0.0246)
Sharp	0.0053	-0.0223	-0.0501*	-0.0635	-0.0700	-0.0503	-0.0063	0.0005	0.0175
	(0.0202)	(0.0167)	(0.0270)	(0.0496)	(0.1182)	(0.0504)	(0.0386)	(0.0361)	(0.0650)
Broad Reaching	-0.0096*	-0.0039	-0.0057	-0.0166	-0.0692**	-0.0214	-0.0348***	-0.0170*	-0.0533***
	(0.0053)	(0.0044)	(0.0079)	(0.0138)	(0.0333)	(0.0130)	(0.0108)	(0.0101)	(0.0189)
New Issue	0.0197***	0.0175***	0.0323***	0.0502***	0.1855***	0.0601***	0.0556***	0.0373***	0.0602***
	(0.0056)	(0.0048)	(0.0089)	(0.0156)	(0.0369)	(0.0145)	(0.0121)	(0.0109)	(0.0196)
OLS regression using all dummy coefficients									
High Severity	0.0004	0.0003	-0.0006	0.0050	0.0070	-0.0026	-0.0014	0.0021	0.0029
	(0.0017)	(0.0027)	(0.0045)	(0.0081)	(0.0207)	(0.0079)	(0.0047)	(0.0033)	(0.0028)
Sharp	0.0018	0.0006	0.0012	0.0180	0.0228	0.0080	0.0047	0.0052	0.0016
	(0.0043)	(0.0069)	(0.0119)	(0.0216)	(0.0550)	(0.0210)	(0.0123)	(0.0085)	(0.0072)
Broad Reaching	-0.0014	0.0000	-0.0015	-0.0028	-0.0218	-0.0103*	-0.0061*	-0.0021	-0.0042*
	(0.0013)	(0.0020)	(0.0035)	(0.0062)	(0.0160)	(0.0061)	(0.0036)	(0.0025)	(0.0022)
New Issue	0.0070***	0.0096***	0.0130***	0.0290***	0.1023***	0.0381***	0.0190***	0.0146***	0.0118***
	(0.0014)	(0.0023)	(0.0040)	(0.0072)	(0.0185)	(0.0070)	(0.0041)	(0.0029)	(0.0024)

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 6: EGARCH-Estimated Response to Corporate Reputational Disaster as Separated by Market Capitalisation (M.Cap)

	[-60,-1]	[-20,-1]	[-10,-1]	[-5,-1]	[t_0 ,+1]	[t_0 ,+5]	[t_0 ,+10]	[t_0 ,+20]	[t_0 ,+60]
M.Cap >= 0.8	0.0001	-0.0005	-0.0004	-0.0004	-0.0012	-0.0001	0.0005	-0.0006	-0.0004
	(0.0009)	(0.0007)	(0.0008)	(0.0011)	(0.0014)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
0.6 <= M.Cap <0.8	0.0001	-0.0007	-0.0002	0.0004	0.0001	-0.0001	-0.0004	-0.0002	0.0002
	(0.0009)	(0.0008)	(0.0008)	(0.0011)	(0.0014)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
0.4<= M.Cap <0.6	0.0002	0.0001	0.0005	0.0002	0.0007	0.0001	0.0007	0.0004	-0.0002
	(0.0009)	(0.0007)	(0.0008)	(0.0011)	(0.0015)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
0.2 <= M.Cap <0.4	0.0001	-0.0005	-0.0006	-0.0002	-0.0003	0.0001	0.0009	0.0004	0.0003
	(0.0009)	(0.0007)	(0.0008)	(0.0011)	(0.0014)	(0.0009)	(0.0007)	(0.0007)	(0.0006)
M.Cap < 0.2	-0.0007	-0.0026***	-0.001	-0.0001	0.0002	-0.0032***	-0.0019***	-0.0001	-0.001*
	(0.0009)	(0.0007)	(0.0007)	(0.0011)	(0.0014)	(0.0009)	(0.0007)	(0.0007)	(0.0006)

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Results in the above Table are separated by quintiles as ranked by the respective natural logarithm of company market capitalisation, defined using the natural logarithm of market capitalisation as measured in US dollars on the respective event date. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: EGARCH-Estimated Response to Corporate Reputational Disaster as Separated by CSR Strategy Score

	[-60,-1]	[-20,-1]	[-10,-1]	[-5,-1]	[t_0 ,+1]	[t_0 ,+5]	[t_0 ,+10]	[t_0 ,+20]	[t_0 ,+60]
CSR >= 0.8	-0.0021***	0.0002	0.0005	-0.0001	-0.0008	-0.0018**	-0.0022***	0.0006	-0.0016***
	(0.0008)	(0.0007)	(0.0007)	(0.001)	(0.0013)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
0.6 <= CSR <0.8	0.0002	-0.0018***	-0.0009	-0.0019*	-0.0018	-0.0014*	0.0005	-0.0002	-0.0005
	(0.0008)	(0.0007)	(0.0007)	(0.001)	(0.0013)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
0.4<= CSR <0.6	0.0001	-0.0003	-0.0001	0.0001	0.0005	0.0001	0.0001	-0.0001	0.0002
	(0.0008)	(0.0007)	(0.0007)	(0.001)	(0.0013)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
0.2 <= CSR <0.4	0.0003	-0.0002	0.0001	0.0007	0.0003	-0.0002	0.0003	-0.0004	-0.0002
	(0.0008)	(0.0007)	(0.0007)	(0.001)	(0.0013)	(0.0008)	(0.0007)	(0.0006)	(0.0005)
CSR < 0.2	0.0001	-0.001	-0.0008	-0.0006	0.0003	0.0003	0.0004	0.0001	0.0003
	(0.0008)	(0.0007)	(0.0007)	(0.001)	(0.0013)	(0.0008)	(0.0007)	(0.0006)	(0.0005)

Note: To investigate the influence of biodiversity-related reputational disaster on international corporations, we utilise the mean equation of the EGARCH(1,1) methodology as $r_t = a_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 I_t + b_4 d_t + \varepsilon_t$, where we include an additional d_t term in our analysis to provide a coefficient relating to the observed return differential for each of our investigated events. To adequately and robustly assess the period surrounding each event, we measure internationally adjusted returns using multiple estimation windows of three months around each identified event, which is assumed to occur at t_0, across a variety of different event windows, including [-60,-1], [-20,-1], [-10,-1], [-5,-1], [t_0,+1], [t_0,+5], [t_0,+10], [t_0,+20], and [t_0,+60] to test the pricing response both before and after the dates on which significant reputational events occur. For brevity of presentation, additional methodological specifications, variations of international factors and windows of analysis, and accompanying placebo tests have been omitted; however, they are available from the authors upon request. Results in the above Table are separated by quintiles as ranked by respective corporate CSR Strategy Score, as collated from the Thomson Reuters Eikon database, which reflects a company's practices to communicate that it integrates economic (financial), social and environmental dimensions into its day-to-day decision-making processes. Data is obtained for the closest reporting date to that on which the event occurs. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Differential Response to Biodiversity-Related Reputational Violation Based on Respective Corporate Characteristics

Variable	Total	Sharp	Unsharp	Low Sev	High Sev	Low Reach	High Reach	Low Nov	High Nov
M.Cap	0.0286	0.0334	-0.0518	-0.0965	0.0424	0.0307	-0.0189	0.0307	-0.0189
	(0.0476)	(0.0472)	(0.7358)	(0.1480)	(0.0509)	(0.0574)	(0.0852)	(0.0574)	(0.0852)
Rev.Surprise	0.0002	0.0003	0.0786	-0.0010	0.0006	0.0005	-0.0006	0.0005	-0.0006
	(0.0008)	(0.0008)	(0.3960)	(0.0017)	(0.0010)	(0.0010)	(0.0016)	(0.0010)	(0.0016)
Vol12m.	0.0005	0.0014	-0.0796	-0.0069	0.0014	0.0026	0.0022	0.0026	0.0022
	(0.0069)	(0.0068)	(0.0923)	(0.0212)	(0.0073)	(0.0096)	(0.0098)	(0.0096)	(0.0098)
Global.Cred.Rank	-0.0058**	-0.0050	-0.0499*	-0.0015**	-0.0062	-0.0085**	0.0004	-0.0085**	0.0004
	(0.0029)	(0.0029)	(0.0447)	(0.0087)	(0.0031)	(0.0036)	(0.0050)	(0.0036)	(0.0050)
Cred.Vol.	0.0088	0.0093	-0.1626	0.0034	0.0096	0.0141	0.0069	0.0141	0.0069
	(0.0073)	(0.0072)	(0.1528)	(0.0232)	(0.0077)	(0.0101)	(0.0105)	(0.0101)	(0.0105)

Note: To provide additional explanatory value, the presented return differentials resulting from the RepRisk-defined biodiversity events are then considered in a methodology that encapsulates a number of distinct corporate characteristics. Each selected variable has been considered for various reasons, primarily surrounding the many industrial and sectoral pressures that exist, to identify whether deteriorating financial performance can be observed as an explanatory factor when considering the financial market response to such significant reputational disasters. The data considered include Revenue Surprise, the natural logarithm of company market capitalisation, the Credit Combined Global Rank, the twelve-month Volatility Rank, and the Credit Structural Asset Volatility Global Rank. We consider the results surrounding event windows $[t_0,+1]$ to test whether corporate characteristics can explain whether such differential stock market response diminishes or perhaps persists in varying manners due to corporate factors. All examined analysis windows were considered in this secondary analysis; however, for the brevity of presentation, only the event window $[t_0,+1]$ is presented. All other results are available from the authors upon request. Corresponding placebo group procedures represent dummy variables that utilise analysis windows based on dummy variables that are re-considered when progressed six months into the future from the original identified date of a biodiversity-linked reputational event. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.