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Corporate Biodiversity Exposure and the Market Response to Earnings Announcements *

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Abstract

Biodiversity loss is increasingly recognized as a material financial risk to firms, yet little is known about how biodiversity-related exposure affects the way capital markets process earnings disclosures.We examine whether corporate biodiversity exposure (CBE), defined as the extent to which a firm's polluting facilities are located near conservation-priority areas, shapes investors' responses to earnings announcements. Drawing on the disclosure-processing-cost framework, we argue that CBE raises disclosure-processing costs at the integration stage by introducing spatially localized ecological and regulatory complexity, which makes it more difficult for investors to integrate reported earnings into valuation-relevant expectations of future cash flows. Consistent with this prediction, firms with higher CBE exhibit weaker earnings response coefficients, indicating attenuated market responsiveness to earnings announcements. These effects are amplified under greater ecological and regulatory uncertainty and attenuated in stronger information environments and under greater external monitoring. Exploiting staggered protected-area expansions in a stacked difference-in-differences design, we provide causal evidence that newly exposed firms experience a decline in earnings–return sensitivity. Overall, our findings identify biodiversity exposure as a place-based disclosure-processing friction and highlight how disclosure and governance shape the pricing of earnings announcements in the presence of ecological complexity.

Keywords: Corporate Biodiversity Exposure; Earnings Response Coefficients; Disclosure Processing Costs; Information Environment

JEL Classifications: M41, G14, G34, Q56, Q57

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1. Introduction

The accelerating loss of biodiversity has emerged as a material financial risk with broad implications for firms, investors, and the global economy (Dasgupta, 2021; NGFS, 2022). Policymakers and regulators have responded with initiatives that elevate biodiversity within corporate reporting and risk management, including the 2022 Kunming–Montreal Global Biodiversity Framework and the European Union's Corporate Sustainability Reporting Directive (Directive (EU) 2022/2464). Reporting frameworks and standards have likewise begun embedding biodiversity considerations into corporate disclosures, most prominently through the Taskforce on Nature-related Financial Disclosures (TNFD) recommendations (TNFD, 2023) and the European Sustainability Reporting Standards (ESRS).[1] Financial regulators and central banks, including the Network for Greening the Financial System, warn that biodiversity loss threatens economic resilience and financial stability. Consistent with these concerns, institutional investors increasingly view biodiversity as a financially material risk (Giglio et al., 2025; Garel et al., 2024).[2]

Translating ecological constraints into financial terms poses distinctive challenges for capital markets, particularly when firms operate near protected or conservation-priority areas. In such settings, investors interpreting earnings announcements must integrate reported earnings with spatially granular ecological and regulatory considerations, such as land-use restrictions, enforcement actions, or reputational pressures, that complicate valuation and raise the cost of forming cash-flow expectations. This challenge reflects high disclosure-integration costs rather than limitations in information availability: even when relevant information is publicly observable, processing and integrating it with earnings is costly, and

[1]The International Sustainability Standards Board has committed to incorporating TNFD recommendations into future standards. ESRS E4, effective since January 2024 with phased implementation, mandates disclosures on biodiversity impacts, risks, and mitigation strategies, and explicitly references TNFD's LEAP framework.

[2]For example, the May–June 2025 Responsible Investor Nature and Investors Survey reports that 56% of global asset managers and owners were "seriously concerned" about the impact of nature loss on financial markets, while another 42% were "somewhat concerned." See Responsible Investor: Nature and Investors Survey 2025.

stock-price responses at the announcement are correspondingly weaker (Blankespoor et al., 2020). Unlike climate risk or industry-level regulation, biodiversity exposure is inherently spatial, facility-specific, and governed by overlapping authorities, making it uniquely difficult to integrate into earnings-based valuation. Investor surveys reinforce this view, indicating that the primary bottleneck is not data availability but linking biodiversity exposure to firm-level business models and future cash-flow expectations.[3] Using earnings announcements as a benchmark disclosure, we examine whether biodiversity-related ecological and regulatory complexity amplifies these frictions.

Despite the growing recognition of biodiversity loss as a financially material concern, it remains unclear whether biodiversity-related uncertainty affects how markets process even the most standardized and salient corporate disclosures, such as earnings announcements. While recent studies in finance examine biodiversity risk in asset pricing and portfolio contexts (e.g., Giglio et al., 2025; Garel et al., 2024), this literature remains nascent relative to climate risk research and focuses primarily on valuation outcomes rather than the processing of firm-level disclosures at the time they are released. Likewise, the extensive literature on earnings announcements and market reactions identifies firm characteristics, governance structures, and institutional environments as key determinants of stock-price responses to earnings announcements, focusing on the level and evolution of earnings response coefficients and related measures. However, this literature does not account for the ecological context in which firms operate and has not examined whether spatially localized ecological constraints raise investors' costs of integrating earnings disclosures into valuation. As a result, we lack evidence on whether corporate biodiversity exposure affects investors' ability to integrate reported earnings disclosures into expectations of future cash flows. This gap motivates our central research question: Does corporate biodiversity exposure attenuate the market's

[3] As Lucian Peppelenbos, Climate and Biodiversity Strategist at Robeco, notes in his commentary on the 2023 Robeco Global Climate Survey: "The real challenge is to connect biodiversity data in meaningful ways to company data. How does the business model of a specific company depend on ecosystem services, and how does that company and its value chain contribute to ecosystem decline?" See Robeco Climate Survey: Biodiversity investing is becoming mainstream, Robeco Insight, May 5, 2023. https://www.robeco.com/en-us/insights/2023/05/robeco-climate-survey-biodiversity-investing-is-becoming-mainstream.

responsiveness to earnings announcements?

Our framework builds on the literature on information frictions, which shows that uncertainty and noise reduce the clarity of disclosures and raise investors' information-processing costs, including disclosure-processing costs at earnings announcements (Verrecchia, 1982; Diamond, 1985; Fischer and Verrecchia, 2000; Hirshleifer et al., 2009; Blankespoor et al., 2020). We extend this perspective to biodiversity by arguing that proximity to protected or conservation-priority areas introduces ecological and regulatory uncertainty that complicates how markets interpret earnings announcements. Even absent immediate disruptions, the prospect of future regulation, litigation, activism, or ecological degradation weakens investors' ability to integrate reported earnings into valuation-relevant expectations of future cash flows. Consistent with this view, a growing number of U.S. firms now explicitly discuss biodiversity risks in their 10-K filings (Garel et al., 2024). These considerations raise disclosure integration costs at the time of earnings announcements, reducing the precision with which prices reflect earnings information at the time of the announcement. Accordingly, we hypothesize that firms with greater corporate biodiversity exposure exhibit weaker contemporaneous stock-price sensitivity to earnings surprises, measured using earnings response coefficients.

A central requirement of our analysis is a reliable firm-level measure of biodiversity exposure. We construct this measure by linking polluting facilities to nearby legally protected areas using high-resolution geospatial data from the World Database on Protected Areas (WDPA). We focus on polluting facilities because biodiversity-related financial risk arises primarily where firms' operations generate ecological externalities, making proximity to protected lands most likely to translate into regulatory exposure, operational constraints, and investor uncertainty. Specifically, for each firm we calculate the total surface area of protected lands within a fixed radius of all the firm's polluting facilities, scaled by the total protected area in the United States. This approach provides a transparent and replicable alternative to proprietary footprint models or ad hoc textual classifications (Karolyi and Tobin-de la

Puente, 2023; O'Dwyer, 2024) and aligns with recent calls for location-specific biodiversity risk assessment. An area-based metric captures variation in ecological sensitivity and regulatory salience in a way that simple site counts cannot, particularly when multiple protected areas cluster around a facility. The resulting measure offers a policy-relevant tool for assessing permitting constraints, biodiversity offsets, and potential liabilities, and it serves as the basis for our empirical analysis. Because this information is publicly observable yet costly to integrate at the time of earnings announcements, corporate biodiversity exposure therefore serves as a proxy for disclosure-processing frictions at earnings announcements.

We test our hypothesis using a panel of U.S. publicly traded firms from 1990 to 2021. We find that firms with greater biodiversity exposure exhibit weaker market reactions to earnings announcements, consistent with higher disclosure-processing costs. The effect is economically meaningful: a one-percentage-point increase in protected land near a firm's facilities corresponds to a 4.5 percent reduction in the return differential between firms in the top and bottom deciles of earnings surprises. These results remain robust to alternative constructions of corporate biodiversity exposure, including site-weighted, distance-weighted, and categorical measures. We also find that firms with greater biodiversity exposure exhibit lower abnormal trading volume and wider bid–ask spreads around earnings announcements, consistent with reduced investor participation and elevated disclosure-processing costs.

To establish causality, we implement a stacked difference-in-differences design that exploits the staggered expansion of protected areas. Firms that become newly exposed to conservation zones experience a significant decline in earnings response coefficients following designation, consistent with biodiversity exposure raising disclosure integration costs and dampening the pricing of earnings announcements. Complementary falsification and timing placebo tests confirm that this effect does not reflect correlated firm traits or spurious return dynamics. In particular, analogous exposure measures constructed using non-polluting facilities do not generate comparable earnings-announcement effects, reinforcing the interpretation that biodiversity exposure is economically relevant for investors primarily in settings where ecological risks are salient. Additional analyses show no evidence of anticipatory pricing or post-earnings-announcement drift, indicating that biodiversity exposure does not merely shift the timing of price discovery. Together, these tests provide causal evidence that biodiversity exposure weakens market responsiveness by increasing investors' costs of integrating earnings information.

To assess the robustness of this interpretation, we conduct an extensive set of robustness tests to assess the stability of our findings and address concerns about omitted variables. Specifically, we control for firms' geographic footprint, ESG orientation, and earnings quality, as well as macro-level climate risks, including policy stringency, international climate summit activity, long-run warming trends, and natural disasters. Across all specifications, the negative relation between corporate biodiversity exposure and the pricing of earnings announcements remains both economically and statistically robust. These results indicate that biodiversity exposure does not merely proxy for correlated sustainability characteristics or broader environmental shocks, but instead represents a distinct disclosure-processing friction that dampens contemporaneous price responsiveness to earnings announcements.

Additional analyses further elucidate the mechanism by showing that the attenuation in earnings response coefficients is not uniform across firms but varies systematically with institutional context and the quality of the information environment. From an institutional perspective, we find greater attenuation in ecologically fragile states, jurisdictions with stricter regulatory enforcement, and counties with weaker stakeholder oversight. In these settings, heightened uncertainty about potential liabilities, compliance costs, and reputational pressures raise investors' disclosure-processing costs when interpreting earnings announcements. From a firm-level perspective, stronger transparency and monitoring mitigate these frictions. Firms that disclose biodiversity information, attract greater analyst coverage, exhibit higher institutional ownership, or face heightened media and scrutiny experience less attenuation in the pricing of earnings announcements. These results collectively indicate that the effect of biodiversity exposure on earnings-based price discovery depends on institutional and information infrastructures, such that identical ecological risks can generate markedly different capital market outcomes depending on whether disclosures and external monitoring alleviate or exacerbate investors' disclosure-processing costs.

Overall, our findings show that biodiversity exposure is not only an ecological or regulatory concern but also a structural challenge for capital markets. Rooted in spatial and ecological contexts that firms cannot fully diversify away or standardize through conventional reporting, biodiversity exposure systematically weakens earnings-based price discovery across industries and regions. Our evidence is consistent with elevated disclosure-processing costs: when ecological context is complex, investors place less contemporaneous weight on earnings surprises, attenuating market responsiveness to earnings announcements. These mechanisms highlight the importance of emerging disclosure initiatives, such as the TNFD and ESRS, which aim to lower disclosure-processing and integration costs at the time of earnings announcements. While our analysis focuses on market responsiveness to earnings announcements, the broader implication is that incorporating biodiversity considerations into financial reporting can help sustain the efficiency of price discovery and the resilience of capital markets as ecological constraints intensify.

Thus, our study makes three contributions to the literature. First, we introduce a new dimension to the earnings announcements literature by identifying biodiversity exposure as an ecologically grounded source of disclosure-processing frictions that attenuates investors' interpretation of earnings announcements. Prior research emphasizes firm characteristics, governance structures, and institutional environments as key determinants of market reactions to earnings announcements (e.g., Bushman et al., 2004; Ferri et al., 2018; Tsang et al., 2025), while the ecological context in which firms operate has received little attention. We extend this literature by showing that proximity to conservation-priority areas weakens contemporaneous market responsiveness to earnings announcements, consistent with higher disclosure-processing costs (Blankespoor et al., 2020). Firms with higher corporate biodiversity exposure exhibit lower earnings response coefficients and no evidence of post–earnings-announcement drift, indicating that investors rationally discount earnings signals that are costly to integrate at the time of the announcement rather than gradually incorporating them over time.

Second, we show that biodiversity exposure represents a distinct and underexplored dimension of nature-related financial risk that operates, in part, through an informational channel. Our findings indicate that biodiversity exposure attenuates the market's responsiveness to earnings announcements by increasing the difficulty of integrating reported performance into valuation-relevant expectations of future cash flows. In this respect, biodiversity exposure differs from climate risks, which prior studies show primarily affect firms through physical damages or transition-related costs (e.g., Engle et al., 2020; Ginglinger and Moreau, 2023). This distinction matters because biodiversity exposure is inherently location-specific, difficult to diversify, and often underrepresented in prevailing disclosure practices. By documenting this informational channel, we show how biodiversity loss can generate informational externalities that impair earnings-based price discovery for exposed firms.

Third, we contribute to the disclosure and policy literatures by showing that the market consequences of biodiversity exposure depend critically on the surrounding information environment. We find that biodiversity-related frictions are more pronounced in settings characterized by greater ecological and regulatory uncertainty, but are mitigated when firms provide more transparent disclosures or are subject to stronger external monitoring. These results demonstrate how ecological context and information infrastructures jointly shape the efficiency of earnings-based price discovery and align with emerging initiatives such as the TNFD and ESRS, which emphasize spatially explicit, nature-related disclosures. Collectively, our evidence suggests that biodiversity exposure is not only a firm-level concern but also a structural challenge for the transmission of earnings information, underscoring the role of disclosure in sustaining efficient capital markets as ecological constraints intensify.

2. Institutional Context and Hypothesis Development

Protected areas are legally designated lands established to conserve biodiversity, safeguard ecosystems, and preserve sites of ecological or cultural significance. Unlike environmental regulations that respond after degradation occurs, protected areas are proactive, place-based measures designed to prevent biodiversity loss within defined boundaries. Empirical evidence shows that well-managed protected areas can slow species declines and sustain higher species richness than comparable unprotected sites (e.g., Coetzee et al., 2014; Gray et al., 2016). By restricting land use and enforcing conservation rules, they preserve habitats, restore endangered populations, and maintain ecological balance.

The United States maintains one of the world's largest and most diverse networks of protected areas. As of 2025, they cover more than 1.2 million square kilometers, representing about 13% of the U.S. landmass and nearly 9% of the world's protected terrestrial areas (UNEP-WCMC, 2025). This conservation tradition traces back to Yellowstone National Park, established in 1872 as the world's first national park. Today, U.S. protected areas are governed by a multilayered framework. Federal lands are regulated by the National Park Service Organic Act, the Wilderness Act, and the Federal Land Policy and Management Act, while broader statutes such as the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA) provide nationwide protections. Regulatory influence also reaches beyond designated boundaries: the Environmental Protection Agency's Prevention of Significant Deterioration program and ESA-designated critical habitats can constrain development even outside park limits. These spillovers raise compliance costs, constrain operational flexibility, and increase reputational risks for firms in land-intensive or extractive industries (Pfaff and Robalino, 2017). For investors, protected areas introduce substantial informational complexity. Evaluating a firm's exposure requires integrating geospatial proximity, ecological sensitivity, and overlapping regulatory constraints into forward-looking valuation assessments. This integration of diverse and non-standardized signals is costly, positioning protected areas as a salient source of disclosure-processing frictions in financial markets.

As of September 2022, the U.S. contained 42,824 protected areas spanning federal, state, local, private, and Indigenous governance structures (UNEP-WCMC, 2025). Since 1990, more than 13,000 new sites have been designated, reflecting an expanding and heterogeneous conservation landscape. The IUCN classification system further distinguishes sites by conservation intensity: strict nature reserves (Categories Ia–Ib) prohibit nearly all human activity, national parks (Category II) permit limited recreation, Categories III–IV emphasize species- or habitat-specific protection, and Categories V–VI allow sustainable resource use. Figure 1 illustrates the geography of U.S. protected areas, shading stricter categories in dark green and multi-use zones in lighter tones. This variation highlights that firms' biodiversity exposure depends not only on geographic proximity but also on the ecological and regulatory salience of nearby areas. Accounting for such heterogeneity requires investors to integrate geospatial data with nuanced legal classifications, amplifying processing costs and complicating how earnings announcements are interpreted in capital markets.

Despite their scale and economic importance, protected areas remain largely absent from corporate disclosure standards and underexplored in finance and accounting research. Most ESG metrics focus on climate-related risks summarized by scalar measures such as emissions intensity. In contrast, biodiversity exposure is inherently spatial and context-specific, varying with proximity to ecologically sensitive sites and overlapping regulatory regimes. This complexity creates significant challenges for measurement and comparability: two firms with similar emissions profiles may face materially different biodiversity-related risks depending on where they operate. Moreover, the consequences of exposure extend beyond direct regulatory costs. Firms located near protected areas are more vulnerable to reputational scrutiny from environmental groups, heightened monitoring by regulators, and operational constraints tied to permitting or land-use restrictions. Yet these risks are rarely standardized or systematically incorporated into financial reports or investor communications (Giglio et al., 2025), leaving investors to piece together incomplete or non-standardized information.

Drawing on the disclosure-processing-cost framework in Blankespoor et al. (2020), we argue that biodiversity exposure primarily raises disclosure-processing costs at the integration stage. In what follows, we use disclosure-processing costs as an umbrella term, with biodiversity exposure operating primarily through the integration stage. While information about protected areas is generally observable and accessible, incorporating place-based ecological and regulatory constraints into valuation models is costly and subject to uncertainty. These integration challenges weaken the clarity of earnings announcements as performance signals by increasing the difficulty investors face in integrating reported earnings into expectations of future cash flows. To formalize this mechanism, we build on the literature on information frictions, which emphasizes that market reactions to public disclosures depend not only on the information content of earnings but also on the costs investors incur in processing that information (Verrecchia, 1982; Diamond, 1985; Hirshleifer and Teoh, 2003; Blankespoor et al., 2020). When processing costs are high, because information is complex, ambiguous, or difficult to integrate, investors place less contemporaneous weight on earnings surprises, weakening price responses even in the absence of behavioral bias. Consistent with this view, prior evidence shows that reductions in disclosure-related uncertainty increase stock price responsiveness to earnings announcements (Ferri et al., 2018). We argue that biodiversity exposure operates through this same channel by increasing the costs of integrating earnings disclosures with spatially contingent ecological and regulatory risks.

Biodiversity exposure therefore exemplifies a setting in which localized, non-standardized risks complicate valuation. Firms operating near protected areas face spatially heterogeneous risks that extend beyond administrative boundaries and remain difficult to forecast even when firms are compliant (Pfaff and Robalino, 2017; TNFD, 2023; OECD, 2020). Because these exposures are rarely disclosed in a standardized manner (Giglio et al., 2025), investors bear higher processing costs when interpreting earnings announcements. These frictions reduce the clarity of earnings announcements as signals of firm performance, resulting in weaker market responses for firms with greater biodiversity exposure.

H1: The market response to earnings announcements is lower for firms with greater biodiversity exposure.

If corporate biodiversity exposure weakens the market's response to earnings announcements by raising investors' disclosure-processing costs, then its effects should vary systematically with conditions that shape those costs when investors interpret earnings signals under ecological uncertainty. In particular, the difficulty of integrating biodiversity-related information depends on both the surrounding institutional environment and the firm's information environment. Institutional features such as ecological fragility, regulatory enforcement intensity, local stakeholder oversight, and heightened reputational scrutiny or activism increase the salience and uncertainty of biodiversity-related risks, thereby increasing the difficulty of integrating reported earnings into future cash-flow expectations. Conversely, firm-level transparency and external monitoring, including voluntary biodiversity disclosure, analyst coverage, institutional ownership, and media or NGO scrutiny, can reduce disclosure-processing costs by making spatial and regulatory exposures easier to interpret and incorporate into valuation. These considerations imply that biodiversity exposure should have stronger negative effects on earnings responsiveness in settings characterized by higher disclosure-processing costs and weaker effects where institutional safeguards and firm-level information environments mitigate those costs.

H2a: The negative effect of corporate biodiversity exposure on the market response to earnings announcements is stronger in institutional settings characterized by greater ecological, regulatory, and reputational uncertainty.

H2b: The negative effect of corporate biodiversity exposure on the market response to earnings announcements is attenuated in stronger firm-level information environments that reduce investors' costs of integrating earnings information.

3. Data, Measurement, and Research Design

The data for our main analysis are drawn from multiple sources covering the period 1990–2021. (1) Spatial data on U.S. protected areas are obtained from the WDPA; (2) Facility-level information is drawn from the National Establishment Time-Series (NETS) database compiled by Walls & Associates and from the U.S. Environmental Protection Agency's Toxic Release Inventory (TRI) and Pollution Prevention (P2) databases; and (3) Firm-level accounting data are obtained from Compustat, stock return data from CRSP, analyst earnings forecasts and reported earnings from the I/B/E/S Summary History file, and institutional ownership data from FactSet.

3.1. Constructing Corporate Biodiversity Exposure (CBE)

To construct firm-level measures of corporate biodiversity exposure (CBE), we link geospatial information on protected areas to the locations of polluting facilities, where proximity to sensitive ecosystems is most likely to translate into regulatory, operational, and reputational risk, and aggregate these exposures to their publicly listed parent firms. Facility-level observations are drawn from the NETS database and restricted to establishments subject to the EPA's TRI. Historical Duns & Bradstreet (DUNS) identifiers reported in TRI are matched to NETS establishments and reconciled with Compustat firm identifiers (gvkeys). Because parent names and identifiers evolve over time, we implement a two-stage linkage procedure consisting of fuzzy string matching across NETS, TRI, and Compustat, followed by manual verification of ambiguous matches. This procedure yields a high-confidence mapping between facilities, pollution reporters, and publicly listed parent firms.

For each facility-year, we compute the cumulative surface area of protected lands within a 30-kilometer radius using WDPA geospatial boundaries. These facility-level exposures are aggregated across all TRI-reporting facilities of a parent firm and normalized by the nationwide surface area of protected lands in that year. We adopt a 30-kilometer buffer as a conservative benchmark: sufficiently narrow to capture localized ecological impacts documented in environmental science, yet broad enough to align with regulatory practice while limiting noise from more distant exposures.[4] Anchoring the measure to this spatial benchmark yields a conceptually grounded, empirically supported, and policy-relevant proxy for localized ecological risk that captures the spatial channel most likely to shape investor interpretation of firm performance.

To illustrate the construction of our measure, Figure 2 depicts Toyota's U.S. operations in 1990. Protected areas within a 30-kilometer radius of each facility are shaded in dark green, while TRI-reporting facilities are marked by red stars. The Long Beach, California facility is located near approximately 146 km^2 of protected lands, while the Columbus, Indiana facility is near about 910 km^2. Aggregating across both sites yields a total exposure of 1,056 km^2. Dividing this value by the nationwide surface area of protected lands in 1990 (1,453,580 km^2) produces Toyota's firm-level CBE score of $1{,}056/1{,}453{,}580 = 0.00073$, or 0.073%. This calculation highlights three key design features of our measure. First, it avoids overweighting exposure arising from clusters of small reserves. Second, it assigns proportionally greater weight to larger protected areas, which are more likely to entail meaningful ecological and regulatory constraints. Third, it restricts attention to TRI-reporting facilities, where proximity to ecologically sensitive areas is most likely to heighten regulatory, operational, and reputational risks. Overall, the construction provides a transparent and replicable firm-year measure of biodiversity exposure, which we integrate with quarterly financial and market data to form the firm-year–quarter panel used in our empirical analysis.

[4]Atmospheric dispersion models show that concentrations from large stationary sources decline sharply within the first tens of kilometers downwind (Hinds, 1999; Seinfeld and Pandis, 2016). Ecological studies similarly find that deposition effects on soils, water, and vegetation are strongest near emission sources, typically within a few tens of kilometers (e.g., Likens and Bormann, 1974; Driscoll et al., 2001; Greaver et al., 2012). Consistent with this evidence, EPA's 2024 modeling guidance specifies that Gaussian plume dispersion models apply only up to 50 kilometers from a source (EPA, 2024).

3.2. Market Response Measures and Control Variables

Our hypotheses predict that CBE weakens the market response to earnings announcements by increasing investors' information-processing costs, making it more difficult to integrate reported earnings into expectations about future cash flows. To evaluate this possibility, we examine whether firms' stock-price sensitivity to earnings surprises varies systematically with biodiversity exposure. We rely on standard earnings-based return measures commonly used in the accounting and finance literatures to characterize market responses to earnings announcements (e.g., Ferri et al., 2018; Bhattacharya et al., 2020; Gipper et al., 2020; Tsang et al., 2025).

Market responses are measured using short-window abnormal returns around quarterly earnings announcements. The primary market response variable is the firm's two-day cumulative abnormal return spanning the announcement date, denoted *AbRetn[0,1]*. Abnormal returns are computed as the firm's raw return minus the return on a benchmark portfolio matched on size and book-to-market characteristics using a 5×5 double-sort procedure (Chi and Shanthikumar, 2017). Unexpected earnings are measured using standardized unexpected earnings (SUE), calculated as the difference between the announced earnings per share (EPS) from I/B/E/S and the median of the most recent analyst earnings forecasts, scaled by the stock price per share at the beginning of the quarter. To facilitate comparability across firms and time, SUE is ranked into deciles within each fiscal quarter, yielding the variable $RSUE$.

In this framework, the sensitivity of abnormal returns to unexpected earnings corresponds to the earnings response coefficient (ERC), a standard market-based measure of the market's responsiveness to earnings announcements. ERC is well suited to our setting because it captures how investors interpret and incorporate reported earnings into prices at the time of disclosure, rather than the statistical properties of the earnings series itself. Consistent with convention, we operationalize ERC as the responsiveness of short-window abnormal returns around earnings announcements to unexpected earnings. In our empirical design, this responsiveness is identified through interactions between $RSUE$ and CBE, allowing us to test whether proximity to ecologically sensitive areas attenuates investors' reactions to earnings announcements. Unlike accounting-based proxies such as persistence, smoothness, or accrual quality, which evaluate statistical features of earnings, ERC directly reflects how earnings announcements are incorporated into prices in capital markets.

To isolate the effect of biodiversity exposure on earnings responsiveness, we control for firm characteristics known to influence the earnings–returns relation. These include firm size (log of total market equity), which captures differences in visibility and analyst following that can dampen the marginal value of earnings announcements; book-to-market (the ratio of book equity to market equity), which distinguishes value firms that are often more sensitive to new information from growth firms; leverage (the ratio of total liabilities to total assets), which reflects financial risk and creditor scrutiny that may shape how earnings announcements are priced; and earnings volatility, measured as the standard deviation of quarterly earnings over the prior four years, as less predictable earnings histories tend to make current announcements more informative.

We further account for features of the information environment and investor attention. Institutional ownership and analyst coverage proxy for monitoring and information flow, which can either attenuate or amplify the market response to earnings announcements. A loss indicator controls for asymmetric reactions to bad versus good news, while a Friday-announcement dummy captures reduced investor attention around weekend disclosures (Dellavigna and Pollet, 2009; Hirshleifer et al., 2009). Investor attention is also proxied by cumulative abnormal returns over the 30 days preceding the earnings announcement (Li et al., 2011), reflecting whether pre-event trading activity crowds out attention to new information. Each control variable enters the specification both directly and interacted with unexpected earnings, allowing for flexible adjustment in earnings responsiveness across firms. Appendix A provides detailed variable definitions and construction procedures.

3.3. Empirical Specification

We test whether CBE impairs the market's response to earnings announcements by estimating regressions of firms' short-window abnormal returns on earnings surprises, biodiversity exposure, and their interaction. The unit of observation is the firm–quarter earnings announcement. Our baseline specification is:

$$\begin{aligned} \mathit{AbRetn[0,1]}_{i,t} \quad &= \quad \alpha_0 + \beta_1 CBE_{i,t-1} \times RSUE_{i,t} + \beta_2 CBE_{i,t-1} + \beta_3 RSUE_{i,t} + \sum_k \beta_k X_{i,t-1} \quad (1) \\ &+ \sum_j \beta_j RSUE_{i,t} \times X_{i,t-1} + \phi_t + \gamma_i + RSUE_{i,t} \times \phi_t + RSUE_{i,t} \times \gamma_i + \varepsilon_{i,t}, \end{aligned}$$

where i indexes firms and t denotes fiscal quarter-years. The dependent variable, $\mathit{AbRetn[0,1]}_{i,t}$, is the two-day cumulative abnormal return around the earnings announcement, as defined in Section **3.2**. Earnings surprises are measured by $RSUE_{i,t}$. The coefficient of interest is β_1, which captures whether CBE alters firms' stock-price sensitivity to earnings surprises as reflected in the interaction between biodiversity exposure and $RSUE_{i,t}$. A negative estimate of β_1 indicates that proximity to protected areas dampens the market's responsiveness to earnings announcements.

We include firm fixed effects (γ_i) and time fixed effects (ϕ_t), as well as their interactions with $RSUE_{i,t}$, to absorb unobserved heterogeneity in earnings responsiveness across firms and over time. The vector $X_{i,t-1}$ contains control variables described in Section **3.2**, which are included both directly and interacted with $RSUE_{i,t}$ to ensure that the estimated effect of biodiversity exposure is not confounded by other determinants of the earnings–returns relation. CBE and control variables are lagged by one accounting year. Standard errors are clustered at the firm level.

3.4. Descriptive statistics

Table 1 presents summary statistics for the variables used in the main analysis, based on 104,181 firm–quarter observations spanning 1990–2021. The mean value of CBE is 0.126, with a median of 0.007 and an interquartile range of 0.000 to 0.068. This distribution indicates that while most firms have little or no proximity to protected areas, a nontrivial subset operates in more ecologically sensitive regions. The right-skewness reflects the spatial clustering of conservation zones, which are concentrated in certain geographic areas, as well as systematic industrial site-selection decisions that lead some firms to locate near such zones.. These features underscore substantial heterogeneity in firms' exposure to biodiversity risk.

The distribution of returns around earnings announcements is consistent with prior evidence. The mean value of *AbRetn[0,1]* is close to zero (0.002), with an interquartile range of –0.025 to 0.029, in line with the approximately symmetric announcement-period return distributions documented in earlier ERC studies (e.g., Kothari et al., 2005; Chi and Shanthikumar, 2017). In terms of firm fundamentals, the average market capitalization of sample firms is approximately $1.9 billion, the average book-to-market ratio is 0.522, and average institutional ownership is 45.4%. Other firm characteristics, including analyst coverage and earnings volatility, display wide cross-sectional variation, as documented in prior research (e.g., Dellavigna and Pollet, 2009; Hirshleifer et al., 2009). This variation ensures that the sample spans a broad range of firm sizes, valuation profiles, and information environments.

4. Empirical results

4.1. Baseline Evidence

Table 2 reports baseline regressions examining whether CBE attenuates ERCs. The dependent variable is the two-day cumulative abnormal return around earnings announcements, and the coefficient of interest is the interaction between *CBE* and standardized unexpected earnings (*RSUE*).

We begin in Column (1) with a parsimonious specification including only *RSUE*, *CBE*, and their interaction, providing a simple benchmark for the directional relationship between biodiversity exposure and earnings responsiveness. Column (2) adds firm and quarter-year fixed effects to absorb time-invariant firm characteristics and common shocks, so identification comes from within-firm variation over time. Column (3) builds on Column (2) by adding standard firm-level controls that capture observable sources of variation in earnings responsiveness. In Column (4), we further interact *RSUE* with each control, allowing the earnings–returns relation to vary flexibly with observable firm characteristics. Finally, Column (5), our preferred specification, additionally interacts *RSUE* with firm and quarter-year fixed effects, permitting ERCs to vary nonparametrically across firms and over time. Thus, the standalone effect of *RSUE* is absorbed, and identification comes from cross-sectional variation in the interaction between *CBE* and *RSUE*. The coefficient on $CBE \times RSUE$ therefore captures whether biodiversity exposure systematically attenuates the market's responsiveness to earnings surprises, net of firm- and time-specific differences in earnings responsiveness.

Across all specifications, the coefficient on $CBE \times RSUE$ is negative and statistically significant at the one percent level. In Columns (1)–(4), the estimates range from –0.007 to –0.008 with standard errors below 0.002. In the fully specified model (Column 5), the coefficient is –0.005 (p = 0.002). Economically, because *CBE* is measured in percentage points, a one-percentage-point increase in exposure reduces the return differential between the top and bottom RSUE deciles by approximately 4.5 percentage points ($-0.005 \times (10 - 1) = -0.045$). This magnitude indicates that greater biodiversity exposure is associated with systematically weaker stock-price sensitivity to earnings surprises, consistent with an attenuation of ERCs. In line with our hypothesis, the results suggest that proximity to protected areas increases the difficulty investors face in interpreting and integrating earnings information into valuations, leading to higher disclosure-processing costs and muted market reactions to firm-specific news.

The control variables behave as expected and further support the validity of the specification. Larger firms, firms reporting losses, and firms announcing earnings on Fridays exhibit significantly weaker announcement returns, consistent with prior evidence on investor attention and information salience (e.g., Dellavigna and Pollet, 2009; Hirshleifer et al., 2009). Interaction terms between $RSUE$ and firm characteristics also align with established findings in the ERC literature. For example, the negative and significant coefficient on $RSUE \times Size$ indicates weaker market responses to earnings surprises among larger firms, consistent with greater pre-disclosure information availability reducing the incremental information content of earnings (e.g., Ferri et al., 2018; Gipper et al., 2020). In contrast, the positive and significant coefficient on $RSUE \times LAnalyst$ suggests that stronger information environments amplify earnings responses, consistent with improved dissemination and integration of earnings information (e.g., Bhattacharya et al., 2020; Tsang et al., 2025). Collectively, these results indicate that the baseline design reproduces well-established regularities in the ERC literature while isolating a novel and economically meaningful role for biodiversity exposure.

4.2. Alternative Measures of CBE

In this subsection, we assess the robustness of our baseline findings to alternative constructions of CBE that vary along spatial, ecological, and governance dimensions.

Having established the robustness of the baseline specification, we first examine whether the attenuation of ERCs varies with the spatial proximity of biodiversity exposure. Because CBE is constructed using a 30-kilometer buffer, we re-estimate the baseline model using alternative radii of 20, 40, and 50 kilometers, consistent with ecological deposition studies and EPA regulatory modeling guidance (see Footnote 4).

Table **3** reports results for alternative constructions of CBE, estimated using the specification in Column (5) of Table 2. Columns (1)–(3) examine spatial sensitivity by varying the radius used to construct exposure measures. Across all buffer sizes, the interaction between $RSUE$ and biodiversity exposure is negative and statistically significant, with the strongest attenuation observed at closer geographic proximity. The effect is largest at the 20-kilometer radius ($\beta_1 = -0.009$, $p = 0.009$), attenuates as the buffer expands, and remains statistically significant even at 50 kilometers ($\beta_1 = -0.002$, $p = 0.014$). This monotonic distance gradient indicates that the attenuation of ERCs is driven primarily by localized biodiversity exposure. Consistent with an information-integration mechanism, spatial proximity likely increases investors' processing costs by requiring the incorporation of geographically specific ecological and regulatory considerations. Accordingly, the 30-kilometer buffer serves as a theoretically grounded and empirically stable benchmark that balances signal and noise.

We next examine alternative constructions of CBE that capture variation in ecological importance and institutional oversight beyond simple geographic proximity. The first alternative measure, *CBE_IUCN*, weights nearby protected areas by their IUCN protection category, assigning greater weight to more strictly protected sites (Category I = 6; Category VI = 1; see Appendix B). For each firm-year, we aggregate the category-weighted surface area of all protected sites within 30 kilometers of the firm's domestic facilities and scale this value by the total category-weighted surface area of protected lands in the United States. By construction, *CBE_IUCN* places greater emphasis on exposure to ecologically critical and more stringently regulated areas.

We also distinguish biodiversity exposure by governance authority. *CBE_Gov* captures proximity to government-managed protected lands, which typically feature formal statutory mandates and standardized regulatory oversight, while *CBE_Non_Gov* captures exposure to non-government–managed lands, such as NGO- or community-administered reserves, where oversight relies more heavily on reputational scrutiny and stakeholder engagement. Facility-level exposure within 30 kilometers is aggregated to the firm-year level, and firm-level exposure is defined as the natural logarithm of one plus the aggregated area.

Columns (4)–(6) of Table 3 report the results. For the IUCN-weighted measure, the interaction between *RSUE* and biodiversity exposure is negative and statistically significant, indicating that proximity to more strictly protected areas is associated with a stronger attenuation of ERCs. The governance-based measures further show that exposure under both government- and non-government-managed regimes dampens market responses to earnings announcements, with the strongest attenuation observed for non-government-managed protected areas. Relative to formal regulatory regimes, exposure to NGO- or community-managed areas is associated with greater interpretive and reputational complexity, consistent with higher information-integration costs.

Overall, these results reinforce the robustness of our main finding and show that spatial proximity, ecological importance, and governance context jointly shape how biodiversity exposure conditions the market's response to earnings announcements.

4.3. Alternative Market Response Outcomes

To examine whether the impact of biodiversity exposure extends beyond announcement-period returns, we re-estimate the baseline specification using abnormal trading volume and abnormal bid–ask spreads as alternative market response outcomes. These variables capture distinct but complementary dimensions of investors' responses to earnings announcements, reflecting participation and liquidity provision when processing firm disclosures (e.g., Atiase and Bamber, 1994; Bamber et al., 2011; Tsang et al., 2025). Specifically, *AbVolume[0,1]* is defined as the change in average log dollar trading volume over the two-day announcement window relative to the prior 30-day average, where dollar volume is calculated as price multiplied by shares traded. *AbSpread[0,1]* is defined as the change in average bid–ask spreads over the same window, scaled by the midquote and expressed in percentage terms. Higher values of *AbVolume[0,1]* indicate stronger trading responses to earnings announcements, while higher values of *AbSpread[0,1]* indicate reduced liquidity. If biodiversity exposure raises investors' information-processing and integration costs, we expect weaker trading responses and reduced liquidity around earnings announcements. Accordingly, the regression specification mirrors Eq. (1) but replaces announcement-period abnormal returns with these alternative market response outcomes. Earnings surprises enter the specification in signed form, allowing us to assess whether biodiversity exposure dampens the directional trading and liquidity responses to earnings announcements.

Table 4 reports the results. In Column (1), the coefficient on *CBE* is negative and statistically significant, indicating that firms with greater biodiversity exposure experience smaller abnormal increases in trading volume around earnings announcements. In Column (2), the coefficient on *CBE* is positive and statistically significant, indicating that these firms experience widening bid–ask spreads during the announcement window. Taken as a whole, these results indicate that biodiversity exposure dampens investor participation and reduces liquidity at the time of disclosure. These findings complement the return-based evidence. Firms with greater exposure to biodiversity-sensitive areas not only exhibit weaker price reactions to earnings announcements but also display muted trading activity and higher transaction costs. Consistent with an information-processing framework, these results suggest that biodiversity exposure introduces integration frictions that operate across multiple dimensions of market response, reducing trading intensity and liquidity provision around earnings announcements.

4.4. Causal Identification and Validation

4.4.1 Difference-in-Differences Design

To strengthen the causal interpretation of our findings, we implement a difference-in-differences (DiD) design that exploits the staggered timing of firms' initial exposure to biodiversity conservation areas. The design compares changes in market responsiveness to earnings announcements before and after a firm's facilities first become exposed to protected areas, defined as the year in which land within 30 kilometers of an existing facility receives legal conservation status, with contemporaneous changes for firms whose facilities remain unexposed over the same event window. If biodiversity exposure dampens market responsiveness, treated firms should exhibit a relative decline in ERCs following designation.

Our empirical strategy follows a stacked DiD specification that accommodates staggered treatment timing while preserving a clean control group and a uniform event-time structure. For each firm, the year of initial exposure is defined as the event year ($t = 0$), and we construct a symmetric seven-year window ($[-3, +3]$) around it. Firms newly exposed in year c form the treated cohort, while firms that remain unexposed throughout the window serve as controls. This approach allows us to trace how initial exposure to conservation areas affects the market's responsiveness to earnings announcements.

We estimate the following specification:

$$\begin{aligned} AbRetn[0,1]_{i,t} \;=\; & \alpha_0 + \beta_1 Treat_i \times Post_{i,t} + \beta_2 RSUE_{i,t} \times Treat_i \times Post_{i,t} \\ & + \sum_k \beta_k \mathrm{X}_{i,c,t-1} + \sum_j \beta_j (RSUE_{i,t} \times X_{i,c,t-1}) + \phi_{c,t} + \gamma_{c,i} \\ & + (RSUE_{i,t} \times \phi_{c,t}) + (RSUE_{i,t} \times \gamma_{c,i}) + \varepsilon_{i,t}, \end{aligned} \tag{2}$$

where i, t, and c index firms, fiscal quarter-years, and event-time cohorts, respectively. $Post_{i,t}$ equals one for quarters after a firm first becomes exposed to a protected area. The specification includes cohort-by-firm ($\gamma_{c,i}$) and cohort-by-quarter ($\phi_{c,t}$) fixed effects, which absorb time-invariant firm characteristics and cohort-specific shocks. Standard errors are clustered at the firm level.

Column (1) of Table **5** reports the baseline stacked DiD results. The coefficient on the triple interaction term, $RSUE_{i,t} \times Treat_i \times Post_{i,t}$, is negative and statistically significant (-0.009, $p = 0.024$), indicating that earnings announcements elicit weaker market responses after firms become newly exposed to biodiversity-sensitive areas. In contrast, the coefficient on $Treat_i \times Post_{i,t}$ is statistically insignificant, indicating that the effect operates through changes in the earnings–return relation rather than general valuation shifts.

4.4.2 Dynamic Effects and Event-Time Analysis

To assess timing and persistence, we replace $Post_{i,t}$ with a full set of event-year indicators. Column (2) of Table **5** reports the results. The pre-treatment coefficients ($t = -2$ and $t = -1$) are statistically insignificant, supporting the parallel-trends assumption and ruling out anticipatory effects. The decline in market responsiveness emerges in the year of initial exposure ($t = 0$), intensifies in the following year ($t = +1$, coefficient -0.017, $p = 0.005$), and dissipates thereafter. Coefficients at $t = +2$ and $t = +3$ are small and statistically insignificant. These dynamics indicate that biodiversity exposure dampens market responsiveness to earnings announcements primarily in the short run. Framed within the disclosure cost taxonomy of Blankespoor et al. (2020), initial exposure may increase awareness, acquisition, and especially integration costs, which are highest when investors first confront newly designated conservation constraints. The subsequent fade-out is consistent with learning, information diffusion, and the gradual involvement of intermediaries such as analysts and ESG data providers.

4.4.3 Falsification, Placebo, and Timing Tests

We conduct a unified set of falsification, placebo, and timing tests to validate the identification strategy and rule out alternative explanations. Table **6** summarizes the results. These tests assess whether the attenuation of ERCs reflects correlated firm characteristics, spurious return dynamics, anticipatory pricing, or delayed post-announcement adjustment.

First, we address location-based confounding by re-estimating Eq. 1 using exposure measures constructed around non-polluting facilities ($CBE\_Nonpolluting$). If the attenuation effect merely reflected proximity to protected areas rather than pollution-linked ecological exposure, similar results would obtain. Column (1) shows that the interaction $RSUE \times CBE\_Nonpolluting$ is statistically insignificant, indicating that the effect is specific to environmentally impactful operations. Second, we test for spurious return correlations by estimating Eq. 1 around randomly assigned non-announcement dates within the same fiscal quarter. Because no earnings information is released on these dates, a significant interaction would indicate confounding return dynamics. Column (2) shows no such effect. Third, we examine anticipatory pricing by estimating abnormal returns over the pre-announcement window $[-60, -1]$. Column (3) shows that the interaction between $RSUE$ and CBE is statistically insignificant, indicating that earnings surprises are not systematically priced before announcements among biodiversity-exposed firms. Finally, we test for delayed adjustment consistent with post-earnings-announcement drift by estimating abnormal returns over the $[2, 60]$ window. Column (4) again shows an insignificant interaction, suggesting that biodiversity exposure does not shift price adjustment to later periods. Collectively, these tests confirm that the weaker ERCs of biodiversity-exposed firms are not driven by firm heterogeneity, spurious return dynamics, anticipatory trading, or delayed adjustment. Instead, the attenuation arises upon initial exposure to protected areas and reflects a genuine reduction in contemporaneous market responsiveness to earnings announcements.

5. Mechanisms and Additional Analyses

5.1. Mechanism Tests

Our baseline results indicate that proximity to biodiversity conservation areas introduces information integration frictions that weaken the pricing of earnings announcements. These frictions arise not from missing information, but from the difficulty investors face in integrating earnings signals with spatially localized ecological and regulatory uncertainty. To test Hypotheses H2a and H2b and examine this mechanism more directly, we assess whether the effect of CBE varies systematically with two contextual dimensions: the institutional environment and the firm-level information environment. The institutional environment captures ecological safeguards, regulatory enforcement, and local stakeholder oversight, which shape the salience and uncertainty of biodiversity-related exposures. The firm-level information environment reflects disclosure quality, analyst coverage, institutional ownership, and external monitoring, all of which can mitigate investors' costs of integrating spatial exposures into earnings interpretation. Consistent with our hypotheses, we expect the effect of CBE to be stronger in weaker institutional settings and attenuated where transparency and monitoring improve investors' ability to interpret earnings announcements.

5.1.1 Institutional Environment

Institutional settings play a central role in shaping how biodiversity exposure affects market responses to earnings announcements. Prior research on information frictions predicts that uncertainty and context-specific risks raise investors' costs of integrating earnings disclosures into valuation (Verrecchia, 1982; Diamond, 1985). In each case, we expect the adverse effect of CBE on the market response to earnings announcements to be stronger where ecological protections are weak, enforcement is uncertain, or stakeholder oversight is limited.

We begin with ecological fragility. Fragile ecosystems and weak biodiversity protection frameworks heighten uncertainty about prospective liabilities and regulatory responses (TNFD, 2023; Giglio et al., 2025). In such contexts, investors anticipate greater risks of regulatory intervention, reputational costs, and operational restrictions, but the scale and timing of these exposures remain difficult to quantify. This uncertainty raises investors' costs of integrating earnings information with location-specific ecological constraints and amplifies the frictions induced by biodiversity exposure. To capture ecological fragility, we construct two indicators. The first, *Low_SpeciesProtect*, equals one for firms headquartered in states with below-median values of the Species Protection Index. The second, *Low_BioRating*, equals one for firms in states classified as facing "major challenges" in biodiversity outcomes. Both measures are drawn from the Map of Life project at Yale University.[5]

We next consider regulatory salience. Firms headquartered in jurisdictions subject to heightened environmental enforcement face binding compliance obligations and greater am-

[5] Map of Life, Yale University: `https://bgc.yale.edu/map-of-life`.

biguity about the cost and persistence of earnings. Such contexts highlight ecological risks while complicating investors' assessment of future liabilities. We measure regulatory salience using county-level nonattainment status under the U.S. National Ambient Air Quality Standards (NAAQS). Nonattainment counties fail to meet federal thresholds for pollutants such as ozone or particulate matter and are subject to enhanced scrutiny, mandatory compliance plans, and potential penalties. Following Choy et al. (2024) and Dai et al. (2025), we define *Nonattainment* equal to one for firms headquartered in such counties. We expect the adverse effect of CBE on the market response to earnings announcements to be stronger in these jurisdictions.

Finally, we examine stakeholder oversight. In the absence of direct regulatory intervention, information frictions are likely greater where local monitoring of ecological risks is weak and potential liabilities are less visible. We proxy oversight using two county-level measures. The first, *Low_BioMedia*, relies on biodiversity-related newspaper coverage. Using the dictionary developed by Giglio et al. (2025) and applied to ProQuest newspaper articles between 1990 and 2021, we classify an article as biodiversity-related if it contains at least one keyword and assign local newspapers to counties following Gentzkow and Shapiro (2010). We then count articles by county-year and set *Low_BioMedia* equal to one if coverage falls below the sample median. The second measure, *Low_PopDensity*, is based on county-level population density from the U.S. Census Bureau. Since public scrutiny tends to be stronger in more densely populated regions, we define *Low_PopDensity* equal to one for counties with below-median population density. These measures capture local visibility and community-based monitoring, allowing us to test whether weaker stakeholder oversight heightens the costs investors face in integrating earnings information with biodiversity-related risks.

Table 7 presents the results. Across all specifications, the triple interaction term ($RSUE \times CBE \times Indicator$) is consistently negative and statistically significant, indicating that the effect of biodiversity exposure on the market response to earnings announcements varies systematically with institutional context. The impact is stronger in states with weak species protection or low biodiversity ratings, consistent with fragile ecosystems and limited safeguards amplifying investor uncertainty. It is also more pronounced in nonattainment counties under federal air quality standards, where uncertainty about compliance obligations and exposure to potential liabilities raises the costs investors face in integrating earnings information with ecological and regulatory constraints. Finally, the effect is largest in counties with limited biodiversity-related media coverage or low population density, where weak visibility and community monitoring restrict the flow of contextual information and increase the difficulty investors face in interpreting earnings announcements.

Overall, these results support Hypothesis H2a, showing that the negative effect of biodiversity exposure on earnings-announcement responses is significantly stronger in institutional settings characterized by greater ecological, regulatory, and reputational uncertainty.

5.1.2 Firm-Level Information Environment

Stronger firm-level transparency and external monitoring can attenuate the effect of biodiversity exposure on market responses to earnings announcements by reducing investors' costs of integrating complex, non-standard information into valuation. The literature on information frictions emphasizes that clearer disclosures and the presence of sophisticated intermediaries facilitate the interpretation of earnings signals when relevant contextual information is difficult to process (Verrecchia, 1982; Diamond, 1985). We consider three dimensions of the firm-level information environment: disclosure, financial intermediation, and societal oversight. Each dimension enhances investors' ability to integrate spatial biodiversity exposure into earnings-based valuation, thereby mitigating biodiversity-related integration frictions at the time of earnings announcements.

The first dimension is disclosure. Explicit recognition of biodiversity-related risks in 10-K filings provides a credible signal of managerial awareness and helps investors assess the materiality of exposures that are otherwise spatially diffuse and difficult to interpret. When firms identify biodiversity as a source of operational or regulatory risk, they reduce informational asymmetry and clarify the channels through which exposure may affect future performance. To capture this dimension, we construct an indicator variable, *Biodiversity_Disc*, equal to one if a firm's 10-K filing contains biodiversity-related language, using the text-based classification of Giglio et al. (2025).

The second dimension is financial intermediation by institutional investors, sell-side analysts, and the media. Institutional investors possess specialized expertise and incentives to evaluate environmental exposures and engage in monitoring. Sell-side analysts translate complex or non-standard information into forecasts and recommendations, enabling dispersed investors to interpret the earnings implications of biodiversity exposure. The news media plays a complementary role by increasing the visibility of firms' ecological risks and shaping investor attention. Through monitoring, interpretation, and information dissemination, these intermediaries reduce investors' costs of integrating biodiversity-related context into earnings-based valuation. We measure this dimension using three indicators: *High_IO*, equal to one if institutional ownership is above the sample median; *High_Analyst*, equal to one if analyst coverage is above the median; and *High_Media*, equal to one if firm-level media coverage is above the median.

The third dimension is societal oversight. Although NGOs operate outside financial markets, they increase the visibility and interpretability of ecological risks by supplying externally generated information that investors can reference when evaluating earnings news.[6] By improving the availability of such contextual information, NGO monitoring facilitates investors' integration of earnings disclosures with biodiversity-related risks. To capture this dimension, we construct *High_NGO*, equal to one if the firm is covered by the SigWatch database.

Table 8 reports the results. Across all measures of the firm-level information environment, the triple interaction term ($RSUE \times CBE \times Indicator$) is positive and statistically

[6]For example, NGOs frequently publish firm- and facility-level reports on biodiversity impacts and protected-area conflicts that are publicly accessible and often cited by journalists and analysts (Giglio et al., 2025).

significant, indicating that stronger information environments systematically attenuate the negative effect of biodiversity exposure on the market response to earnings announcements. The dampening effect is most pronounced for firms that explicitly disclose biodiversity-related information, those with greater institutional ownership or analyst coverage, and those subject to heightened media or NGO scrutiny. These results support Hypothesis H2b and indicate that stronger firm-level information environments mitigate biodiversity-related integration frictions by lowering investors' costs of interpreting earnings announcements.

5.2. Additional Analyses

We conduct a series of additional analyses to ensure that the observed attenuation in ERCs among biodiversity-exposed firms is not driven by omitted variables or correlated firm characteristics. These tests assess whether the estimated effect of CBE on market responsiveness persists after accounting for firm-level attributes, sustainability orientation, and broader macro-environmental factors. Table 9 reports the results.

Column (1) controls for the geographic scope of operations, measured as the natural logarithm of one plus the number of polluting facilities. This addresses the concern that the estimated CBE effect may proxy for firm size or operational breadth. Firms with more extensive operations tend to be more diversified and attract greater analyst coverage, which could mechanically dampen earnings responsiveness. Conditioning on operational scope ensures that the CBE effect is not driven by scale-related dynamics.

Column (2) introduces the firm's overall ESG score to control for general sustainability orientation. Firms with stronger ESG profiles may face greater scrutiny, attract ESG-oriented investors, or provide higher-quality nonfinancial disclosures. If these features were responsible for weaker earnings responses, the estimated effect of CBE would attenuate once ESG orientation is included. The persistence of the CBE coefficient suggests that biodiversity exposure captures a distinct source of information-integration frictions, separate from broad sustainability performance.

Column (3) controls for earnings quality using discretionary accruals estimated under the modified Jones model (Dechow et al., 1995). Because lower earnings quality can reduce reporting credibility and dampen ERCs, this specification helps disentangle biodiversity-related integration frictions from those arising from accounting noise.

Columns (4) through (7) incorporate climate-related risk factors following Faccini et al. (2023), including measures of U.S. climate policy stringency, international climate summit activity, long-run warming trends, and natural disaster incidence.[7] These macro-level controls capture environmental and policy conditions that may affect firm performance or investor attention and ensure that biodiversity exposure does not proxy for broader climate-related risks.

Across all specifications, the coefficient on $RSUE \times CBE$ remains negative and statistically significant, with magnitudes comparable to those in the baseline model. This robustness indicates that the attenuation in earnings responsiveness is not driven by operational scale, ESG orientation, financial reporting quality, or correlated climate risks. Instead, the results reinforce the interpretation that proximity to protected areas introduces a distinct source of ecological complexity that raises investors' information-integration costs and weakens market reactions to earnings announcements.

6. Conclusion

This study investigates how CBE affects the market response to earnings announcements. We find that firms with higher CBE exhibit significantly weaker pricing of earnings surprises, consistent with biodiversity-related information integration frictions that complicate investors' incorporation of earnings disclosures into valuation. These frictions are rooted in ecological uncertainty, regulatory and legal risks, and reputational pressures, and are compounded by the lack of standardized, spatially comparable biodiversity disclosures that investors can readily integrate at the time of earnings announcements. In addition to

[7] See Appendix A for variable definitions.

price reactions, we document lower abnormal trading volume and wider bid–ask spreads for high-CBE firms around earnings announcements, consistent with reduced investor participation and heightened information-integration frictions. A stacked DiD design shows that this attenuation arises when firms become newly exposed to biodiversity-sensitive areas, rather than reflecting persistent firm characteristics. Consistent with an information-integration cost mechanism, the absence of post-announcement drift indicates that prices are not correcting delayed incorporation of earnings information, but instead place less contemporaneous weight on earnings signals at the time of disclosure. Complementary falsification, placebo, and timing tests further reinforce the causal interpretation that biodiversity exposure weakens market responsiveness by increasing information-integration costs.

Economically, weaker market responses to earnings announcements imply less precise earnings-based price discovery at the time of disclosure. Prior research suggests that when investors face greater uncertainty in interpreting earnings signals, they demand higher risk premia, which can distort capital allocation across firms, industries, and regions (Easley and O'hara, 2004; Lambert et al., 2007). Although we do not directly examine long-run financing outcomes or welfare implications, our findings indicate that biodiversity exposure may place firms operating in ecologically sensitive areas at a disadvantage. Understanding the longer-term implications of these effects for investment, growth, and regional economic activity remains an important avenue for future research. Overall, our evidence suggests that biodiversity risk is not only an ecological or regulatory concern, but also a factor that can systematically impair earnings-based price discovery in capital markets.

For firms, the results highlight the strategic value of contextualized biodiversity reporting in mitigating information frictions. Voluntary biodiversity disclosure, together with monitoring by analysts and institutional investors and external scrutiny from media and NGOs, attenuates the dampening effect of CBE on earnings responsiveness by improving investors' ability to interpret spatial exposures. For investors, the evidence underscores the importance of assessing not only the degree of exposure to biodiversity risk but also the quality of the surrounding information and institutional environment in which earnings are processed.

At the policy level, our findings support the growing emphasis on spatially explicit and standardized disclosure frameworks, including the TNFD and the ESRS. By improving the comparability and interpretability of biodiversity exposures, such frameworks can reduce information frictions and help sustain the efficiency of earnings-based price discovery as ecological constraints become increasingly salient.

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Figure 1. The Geography of Protected Areas in the United States

The figure maps all protected areas in the contiguous United States, excluding Alaska and Hawaii. The underlying data are obtained from the World Database on Protected Areas (WDPA). The horizontal and vertical axes represent geographic coordinates (longitude and latitude), allowing the spatial distribution of protected areas to be visualized across the continental U.S. Following the IUCN protected area management categories, strictly protected reserves and wilderness areas (Categories Ia and Ib) are shown in dark green, while categories II–VI (ranging from national parks to managed resource areas) are displayed in progressively lighter shades of green. This gradation highlights the variation in management objectives across protected lands, from strict biodiversity preservation to landscapes allowing sustainable use of natural resources.

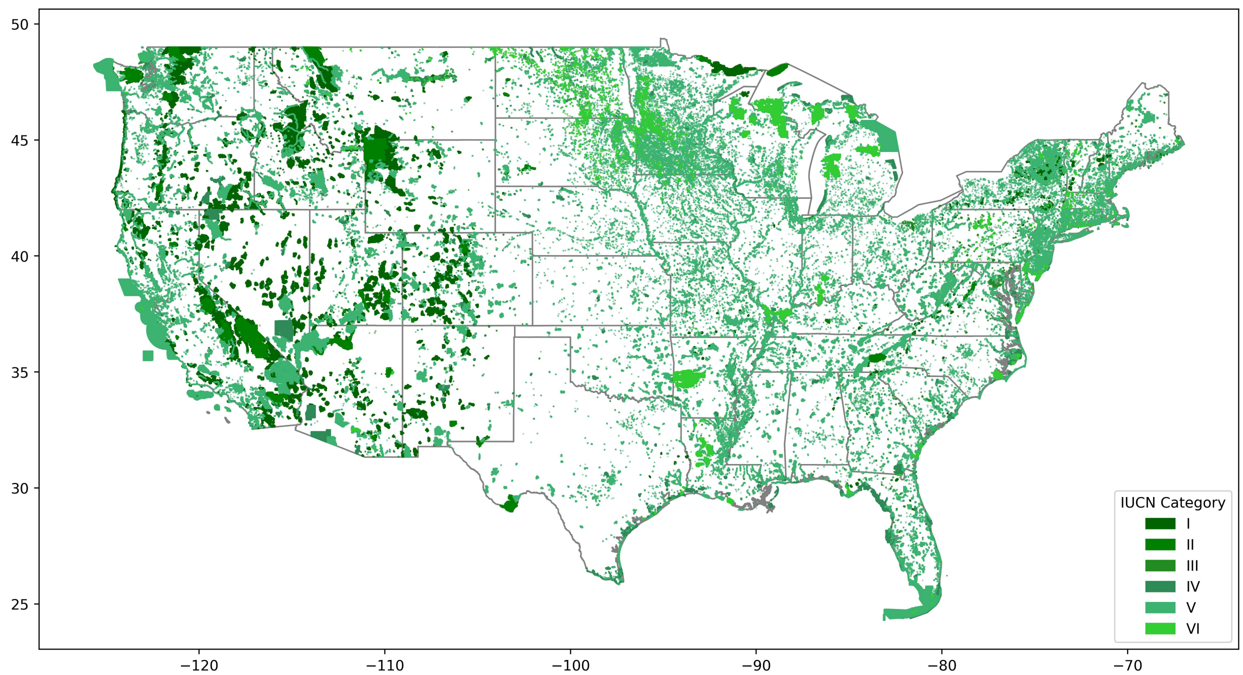

Figure 2. Toyota Motor Corporation's Production Facilities

The figure illustrates Toyota's two U.S. facilities that reported to the Toxics Release Inventory (TRI) in 1990, one in Long Beach, California (left image), and the other in Columbus, Indiana (right image), highlighted with red stars. Protected areas within a 30-kilometer radius are shaded in dark green. Our corporate biodiversity exposure (CBE) metric is defined as the total surface area of these proximate protected areas, expressed relative to the nationwide conservation footprint. This spatial overlay captures the extent to which a firm's operations are situated near ecologically sensitive zones, quantifying potential regulatory and reputational risks.

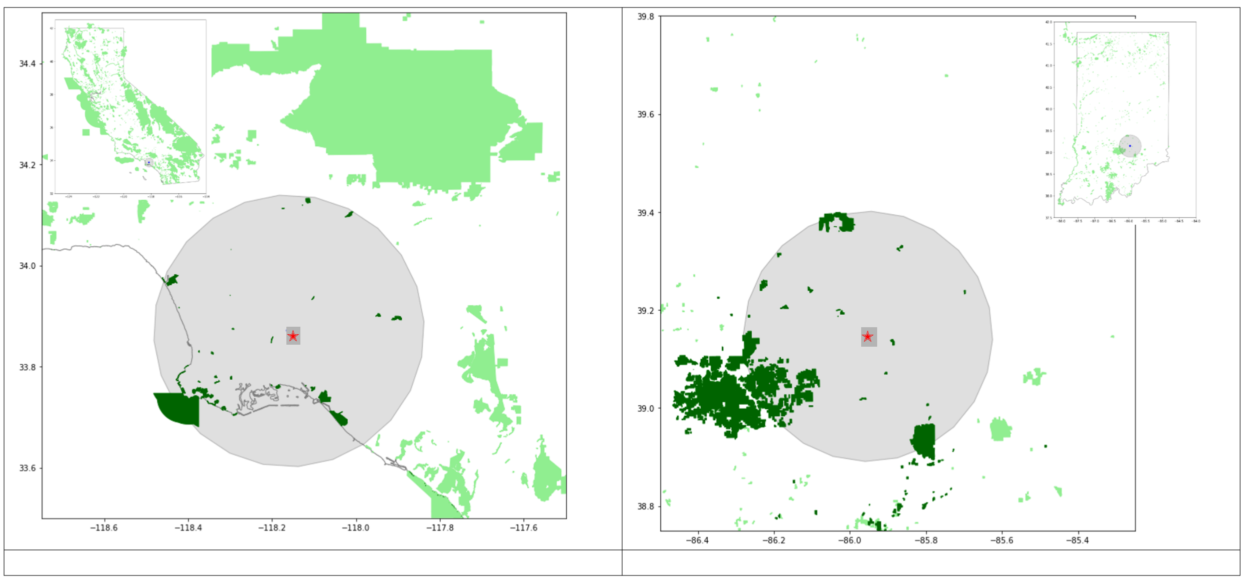

Table 1
Summary Statistics

This table reports descriptive statistics for the main variables used in our empirical analysis, including the number of observations (Observations), mean (Mean), standard deviation (Stdev), 25th percentile (25th), median (50th), and 75th percentile (75th) over the 1990–2021 period. Variable definitions are provided in Appendix A. All continuous variables are winsorized at the 1st and 99th percentiles, except for $AbRetn[0, 1]$.

	Observations	Mean	Stdev	25th	Median	75th
CBE	104181	0.126	0.408	0.000	0.007	0.068
$AbRetn[0, 1]$	104181	0.002	0.044	-0.025	0.001	0.029
$RSUE$	104181	-0.003	0.069	-0.001	0.000	0.002
$Size$	104181	7.540	1.878	6.216	7.484	8.841
$Leverage$	104181	0.564	0.212	0.430	0.569	0.694
BTM	104181	0.522	0.415	0.282	0.455	0.678
IO	104181	0.454	0.365	0.000	0.529	0.783
$LAnalyst$	104181	1.772	0.692	1.099	1.792	2.303
$EarnVol$	104181	0.442	0.599	0.120	0.239	0.494
$BadNews$	104181	0.419	0.494	0.000	0.000	1.000
$Loss$	104181	0.149	0.357	0.000	0.000	0.000
$Friday$	104181	0.093	0.291	0.000	0.000	0.000
$Prior\_AbRetn$	104181	-0.002	0.135	-0.068	-0.003	0.062

Table 2
Biodiversity Exposure and Earnings Response Coefficients (ERCs)

This table reports the effects of corporate biodiversity exposure (CBE) on the market response to earnings announcements, proxied by earnings response coefficients (ERCs) estimated from cumulative abnormal returns $AbRetn[0,1]$. We estimate OLS regressions with alternative fixed-effects specifications, including interactions between $RSUE$ and firm and quarter-year fixed effects. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period spans 1990–2021.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable			*AbRetn[0,1]*		
$CBE \times RSUE$	-0.007***	-0.007***	-0.008***	-0.007***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
CBE	0.004***	0.004***	0.005***	0.004***	0.004***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
$RSUE$	0.039***	0.039***	0.034***	0.047***	
	(0.000)	(0.000)	(0.000)	(0.000)	
$Size$			-0.003***	-0.001***	-0.001
			(0.000)	(0.000)	(0.292)
$Leverage$			0.004***	0.008***	0.002
			(0.003)	(0.000)	(0.575)
BTM			0.007***	0.009***	0.008***
			(0.000)	(0.000)	(0.000)
IO			0.003***	-0.009***	-0.000
			(0.000)	(0.000)	(0.949)
$LAnalyst$			0.002***	-0.000	0.000
			(0.000)	(0.701)	(0.627)
$EarnVol$			0.000	-0.000	0.000
			(0.148)	(0.916)	(0.463)
$BadNews$			-0.003***	0.001	0.001
			(0.000)	(0.286)	(0.300)
$Loss$			-0.009***	-0.008***	-0.006***
			(0.000)	(0.000)	(0.000)
$Friday$			-0.001**	0.004***	0.002**
			(0.014)	(0.000)	(0.040)
$Prior\_AbRetn$			-0.007***	-0.006***	-0.007***
			(0.000)	(0.003)	(0.002)
$RSUE \times Size$				-0.002***	-0.004***
				(0.000)	(0.002)
$RSUE \times Leverage$				-0.009***	0.003
				(0.006)	(0.497)
$RSUE \times BTM$				-0.005***	-0.003*
				(0.000)	(0.070)
$RSUE \times IO$				0.022***	0.005*
				(0.000)	(0.096)
$RSUE \times LAnalyst$				0.005***	0.003**
				(0.000)	(0.029)
$RSUE \times EarnVol$				0.001	-0.000
				(0.383)	(0.714)
$RSUE \times BadNews$				-0.009***	-0.007***
				(0.000)	(0.005)
$RSUE \times Loss$				-0.003*	-0.007***
				(0.083)	(0.000)
$RSUE \times Friday$				-0.010***	-0.006***
				(0.000)	(0.000)
$RSUE \times\ Prior\_AbRetn$				-0.003	-0.004
				(0.464)	(0.324)
Constant	-0.018***	-0.018***	-0.004	-0.011***	0.012***
	(0.000)	(0.000)	(0.193)	(0.001)	(0.000)
Quarter-Year FE	No	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
$RSUE\times$ Quarter-Year FE	No	No	No	No	Yes
$RSUE\times$ Firm FE	No	No	No	No	Yes
Observations	104,231	104,181	104,181	104,181	104,181
Adjusted R^2	0.060	0.067	0.074	0.078	0.098

Table 3
Alternative CBE Measures and ERCs

This table examines the robustness of the baseline earnings response coefficient (ERC) results to alternative constructions of corporate biodiversity exposure (CBE). Columns (1)–(3) assess spatial sensitivity by redefining CBE using buffer radii of 20 (CBE_20KM), 40 (CBE_40KM), and 50 kilometers (CBE_50KM) around firm facilities. Columns (4)–(6) consider alternative constructions of biodiversity exposure based on ecological importance and governance authority, including an IUCN category-weighted measure (CBE_IUCN), exposure to government-managed protected areas (CBE_Gov), and exposure to non-government-managed protected areas (CBE_Non_Gov). Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	*AbRetn[0,1]*					
$RSUE \times CBE\_20KM$	-0.009***					
	(0.009)					
CBE_20KM	0.005**					
	(0.018)					
$RSUE \times CBE\_40KM$		-0.003**				
		(0.025)				
CBE_40KM		0.002***				
		(0.004)				
$RSUE \times CBE\_50KM$			-0.002**			
			(0.014)			
CBE_50KM			0.002***			
			(0.002)			
$RSUE \times CBE\_IUCN$				-0.002***		
				(0.003)		
CBE_IUCN				0.001***		
				(0.000)		
$RSUE \times CBE\_Gov$					-0.005***	
					(0.002)	
CBE_Gov					0.004***	
					(0.000)	
$RSUE \times CBE\_Non\_Gov$						-0.016*
						(0.050)
CBE_Non_Gov						0.009**
						(0.013)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE\times$ Controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE\times$ Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE\times$ Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	104,181	104,181	104,181	104,181	104,181	104,181
Adjusted R^2	0.136	0.136	0.136	0.098	0.098	0.098

Table 4
CBE and Market Microstructure Responses

This table reports the effects of corporate biodiversity exposure (CBE) on alternative measures of market responsiveness to earnings announcements, proxied by abnormal trading volume ($AbVolume[0,1]$) and abnormal bid–ask spreads ($AbSpread[0,1]$). Columns (1) and (2) use abnormal volume and abnormal spread, respectively. Both measures are calculated over the two-day earnings announcement window. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Dependent Variable	$AbVolume[0,1]$	$AbSpread[0,1]$
CBE	-0.018**	0.011**
	(0.020)	(0.018)
$AbsSUE$	0.007	0.006
	(0.390)	(0.661)
$Size$	-0.043***	0.009***
	(0.000)	(0.009)
$Leverage$	0.008	0.042**
	(0.596)	(0.013)
BTM	-0.071***	0.018*
	(0.000)	(0.061)
IO	0.014	-0.011
	(0.119)	(0.110)
$LAnalyst$	0.066***	-0.006
	(0.000)	(0.160)
$EarnVol$	0.023***	-0.004
	(0.000)	(0.148)
$BadNews$	-0.044***	0.016***
	(0.000)	(0.000)
$Loss$	-0.063***	0.028***
	(0.000)	(0.000)
$Friday$	-0.036***	-0.010
	(0.000)	(0.133)
$Prior\_AbRet$	0.210***	-0.241***
	(0.000)	(0.000)
Constant	0.825***	-0.081**
	(0.000)	(0.015)
Quarter-Year FE	Yes	Yes
Firm FE	Yes	Yes
Observations	100,208	92,334
Adjusted R^2	0.200	0.048

Table 5
Stacked Difference-in-Differences (DiD) Estimates of CBE on ERCs

This table reports the effects of corporate biodiversity exposure (CBE) on earnings response coefficients (ERCs) using a stacked DiD design. The estimation sample is restricted within a symmetric seven-year event window $[-3, +3]$, centered on the first year of exposure (Year 0). Firms whose first exposure occurs outside this window are assigned $Treat = 0$ and serve as within-window controls. The specification includes cohort-by-firm and cohort-by-quarter-year fixed effects. Variable definitions are provided in Appendix A. p-values, shown in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Dependent Variable	$AbRetn[0,1]$	
$Treat \times Post$	0.002	
	(0.295)	
$RSUE \times Treat \times Post$	-0.009**	
	(0.024)	
$RSUE \times Treat \times t = -2$		0.003
		(0.700)
$RSUE \times Treat \times t = -1$		-0.004
		(0.504)
$RSUE \times Treat \times t = 0$		-0.012**
		(0.043)
$RSUE \times Treat \times t = 1$		-0.017***
		(0.005)
$RSUE \times Treat \times t = 2$		-0.007
		(0.250)
$RSUE \times Treat \times t = 3$		-0.003
		(0.687)
$Treat \times t = -2$		0.001
		(0.909)
$Treat \times t = -1$		0.002
		(0.658)
$Treat \times t = 0$		0.004
		(0.280)
$Treat \times t = 1$		0.007**
		(0.043)
$Treat \times t = 2$		0.000
		(0.930)
$Treat \times t = 3$		0.001
		(0.768)
Controls	Yes	Yes
$RSUE \times$ Controls	Yes	Yes
Cohort-Quarter-Year FE	Yes	Yes
Cohort-Firm FE	Yes	Yes
$RSUE \times$ Cohort-Quarter-Year FE	Yes	Yes
$RSUE \times$ Cohort-Firm FE	Yes	Yes
Observations	253,608	253,608
Adjusted R^2	0.122	0.122

Table 6
Falsification, Placebo, and Timing Tests for Reduced ERCs

This table reports regression results validating that the reduced earnings response coefficients (ERCs) observed among firms with high corporate biodiversity exposure (CBE) are not driven by correlated firm traits, spurious return dynamics, or timing-related mechanisms. Columns (1) and (2) present location and timing placebo tests designed to verify that the observed ERC attenuation is specific to polluting facilities and true earnings announcement windows, respectively. Columns (3) and (4) evaluate pre- and post-announcement timing mechanisms, anticipatory pricing and post–earnings-announcement drift (PEAD), to ensure that biodiversity exposure does not alter the temporal dynamics of price adjustment. The dependent variables are cumulative abnormal returns adjusted for size and book-to-market factors: $AbRetn[0,1]$ for the two-day earnings announcement window; $Random\_AbRetn[0,1]$ for pseudo-announcement dates; $AbRetn[-60,-1]$ for the 60-day pre-announcement window; and $AbRetn[2,60]$ for the 60-day post-announcement window. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable	$AbRetn[0,1]$	$Random\_AbRetn[0,1]$	$AbRetn[-60,-1]$	$AbRetn[2,60]$
$RSUE \times CBE\_Nonpolluting$	-0.008			
	(0.651)			
$CBE\_Nonpolluting$	0.023**			
	(0.026)			
$RSUE \times CBE$		-0.001	0.003	-0.003
		(0.502)	(0.591)	(0.736)
CBE		0.000	-0.002	0.005
		(0.537)	(0.489)	(0.304)
Controls	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
$RSUE\times$ Quarter-Year FE	Yes	Yes	Yes	Yes
$RSUE\times$ Firm FE	Yes	Yes	Yes	Yes
Observations	152,167	104,181	104,181	104,181
Adjusted R^2	0.085	0.046	0.097	0.145

Table 7
Cross-Sectional Variation in CBE Effects by Institutional Environment

This table reports cross-sectional regression results analyzing how the association between corporate biodiversity exposure (CBE) and earnings response coefficients (ERCs) varies with institutional environment. We estimate interaction terms between $RSUE$, CBE, and indicator variables defined as follows: (i) *Low_SpeciesProtect*, equal to one if the firm's headquarters is located in a state whose Species Protection Index is below the sample median and zero otherwise; (ii) *Low_BioRating*, equal to one if the firm's headquarters is located in a state whose biodiversity rating is classified as "major challenges" and zero otherwise; (iii) *Nonattainment*, equal to one for firms headquartered in counties designated as nonattainment areas under the U.S. National Ambient Air Quality Standards; (iv) *Low_BioMedia*, equal to one for firms headquartered in counties with biodiversity-related media coverage below the sample median; and (v) *Low_PopDensity*, equal to one for firms headquartered in counties with population density below the sample median. The number of observations varies across columns due to data limitations in constructing the respective cross-sectional variables. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Definition of $Indicator$				
	Low_SpeciesProtect	*Low_BioRating*	*Non_attainment*	*Low_BioMedia*	*Low_PopDensity*
Dependent Variable	$AbRetn[0,1]$				
$RSUE \times CBE \times Indicator$	-0.015**	-0.012*	-0.011**	-0.016*	-0.012**
	(0.024)	(0.064)	(0.033)	(0.059)	(0.049)
$RSUE \times CBE$	0.003	0.003	-0.003	0.004	0.004
	(0.438)	(0.539)	(0.329)	(0.196)	(0.381)
$RSUE \times Indicator$	0.007*	0.005	0.008**	-0.008	0.007**
	(0.067)	(0.183)	(0.019)	(0.126)	(0.031)
CBE	-0.001	0.001	0.001	0.002	-0.002
	(0.678)	(0.945)	(0.562)	(0.139)	(0.312)
Controls	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Firm FE $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Controls	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Quarter-Year FE	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Firm FE	Yes	Yes	Yes	Yes	Yes
Controls $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Controls $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Quarter-Year FE $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
$RSUE$ $\times$ Firm FE $\times$ $Indicator$	Yes	Yes	Yes	Yes	Yes
Observations	68,092	68092	49,599	70,099	62,089
Adjusted R^2	0.178	0.177	0.208	0.118	0.130

Table 8
Cross-Sectional Variation in CBE Effects by Information Environment

This table reports cross-sectional regression results analyzing how the association between corporate biodiversity exposure (CBE) and earnings response coefficients (ERCs) varies with disclosure and external monitoring. We estimate interaction terms between $RSUE$, CBE, and indicator variables defined as follows: (i) *Biodiversity_Disc*, equal to one if the firm discloses biodiversity exposure in its 10-K filings and zero otherwise; (ii) *High_IO*, equal to one if the firm's institutional ownership is above the sample median and zero otherwise; (iii) *High_Analyst*, equal to one if the firm's analyst coverage exceeds the sample median and zero otherwise; (iv) *High_Media*, equal to one if the firm's media coverage is above the sample median and zero otherwise; and (v) *High_NGO*, equal to one if the firm is covered by the SigWatch database and zero otherwise. The number of observations varies across Columns (1), (4), and (5) due to data limitations in constructing the respective cross-sectional variables. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Definition of *Indicator*				
	Biodiversity_Disc	*High_IO*	*High_Analyst*	*High_Media*	*High_NGO*
Dependent Variable	$AbRetn[0,1]$				
$RSUE \times CBE \times Indicator$	0.051***	0.009**	0.007*	0.009*	0.006*
	(0.001)	(0.025)	(0.076)	(0.070)	(0.078)
$RSUE \times CBE$	-0.007	-0.005**	-0.007***	-0.008***	-0.006***
	(0.137)	(0.021)	(0.008)	(0.000)	(0.005)
$RSUE \times Indicator$	-0.025***	-0.004*	-0.005**	-0.004	-0.003*
	(0.006)	(0.064)	(0.014)	(0.118)	(0.075)
CBE	0.003	0.003**	0.005***	0.004***	0.004***
	(0.327)	(0.013)	(0.000)	(0.000)	(0.009)
Controls	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Firm FE × *Indicator*	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Controls	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Quarter-Year FE	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Firm FE	Yes	Yes	Yes	Yes	Yes
Controls × *Indicator*	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE × *Indicator*	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Controls × *Indicator*	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Quarter-Year FE × *Indicator*	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Firm FE × *Indicator*	Yes	Yes	Yes	Yes	Yes
Observations	47,654	104,181	104,181	65,022	104,181
Adjusted R^2	0.129	0.116	0.115	0.125	0.120

Table 9
Robustness Tests with Additional Controls

This table reports regression results evaluating the robustness of the main finding that corporate biodiversity exposure (CBE) weakens the market's responsiveness to earnings announcements, measured by earnings response coefficients (ERCs). Columns (1)–(7) report results using additional firm- and macro-level controls. Columns (1)–(3) introduce firm-level controls. Column (1) includes the total number of plants operated by the firm (log-transformed); Column (2) adds the firm's ESG score; and Column (3) incorporates earnings quality, proxied by discretionary accruals estimated using the modified Jones model (Dechow et al., 1995). Columns (4)–(7) incorporate climate-related risk controls from Faccini et al. (2023): the U.S. Climate Policy Index, International Climate Summit Index, Global Warming Index, and Natural Disaster Index. All climate-related indices are aggregated to the monthly level by averaging daily values. Variable definitions are provided in Appendix A. p-values, reported in parentheses, are based on heteroskedasticity-consistent standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Definition of *AddControl*						
	Total Plants	*ESG Score*	*Earn_Quality*	*Climate Policy*	*ClimateSummit*	*Global Warming*	*Natural Disaster*
Dependent Variable	$AbRetn[0,1]$						
$RSUE \times CBE$	-0.004***	-0.008***	-0.005***	-0.007***	-0.007***	-0.007***	-0.007***
	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CBE	0.003***	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$CBE \times AddControl$	-0.004*	-0.003	-0.005	0.002	0.002**	0.004	0.002
	(0.591)	(0.736)	(0.470)	(0.252)	(0.035)	(0.149)	(0.347)
$AddControl$	-0.002	0.001	-0.001	-0.003	-0.003*	-0.006	-0.005
	(0.178)	(0.894)	(0.928)	(0.412)	(0.099)	(0.217)	(0.254)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$RSUE$ × Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	104,181	62,230	95770	68,743	68,743	68,743	68,743
Adjusted R-squared	0.136	0.166	0.140	0.116	0.116	0.116	0.116

Appendix A
Variables and their Definitions

Variable	Definition
Variables Used in the Main Analysis	
CBE	Firm-level exposure to protected areas is defined as the total surface area of protected areas (PAs) located within a 30-kilometer radius of each of the firm's polluting facilities, aggregated across all polluting facilities and scaled by the total area of designated PAs in the U.S. in the corresponding year.
$AbRetn[0,1]$	The size and book-to-market ratio-adjusted cumulative abnormal returns over the two-day trading window following the earnings announcement.
$RSUE$	The decile rank of standardized unexpected earnings (SUE), where SUE is calculated as the difference between the announced earnings per share (EPS) from I/B/E/S and the median of the most recent analyst earnings forecasts, scaled by the stock price per share at the beginning of the quarter.
$Size$	The natural logarithm of a firm's market value of equity at the end of the quarter.
$Leverage$	The leverage ratio, defined as long-term debt plus debt in current liabilities, divided by total assets.
BTM	Book value of equity divided by market value of equity at the end of the quarter.
IO	Proportion of shares held by institutional investors at the end of the quarter
$LAnalyst$	The natural logarithm of one plus the number of analysts who provide quarterly forecasts for a firm.
$EarnVol$	Earnings volatility, defined as the standard deviation of quarterly earnings over the past four years.
$BadNews$	Indicator variable equal to one if the earnings surprise is less than zero and zero otherwise.
$Loss$	Indicator variable equal to one if the firm's net income before extraordinary items is less than zero and zero otherwise.
$Friday$	Indicator variable equal to one if the earnings announcement is released on a Friday and zero otherwise.
$Prior\_AbRetn$	The size- and book-to-market ratio-adjusted cumulative abnormal returns over the 30 days before the test window.
Variables Used in Other Analyses	
CBE_IUCN	The weighted surface area of protected areas (PAs), where each PA's land area is multiplied by its IUCN protection category weight, located within a 30-kilometer radius of each of the firm's polluting facilities, aggregated across all polluting facilities and scaled by the total surface area of designated PAs in the U.S. in the corresponding year.

$CBE\_Gov_Exposed$	The total surface area of protected areas (PAs) located within a 30-kilometer radius of all firm-operated polluting facilities, conditional on at least one PA within the radius managed by a federal or local government agency. In case there are no government-managed PAs in this radius in a given year, the variable takes the value of 0 in that year. This metric is scaled by the total area of designated PAs in the U.S., in the corresponding year.
$CBE\_Non\_Gov\_Exposed$	The total surface area of protected areas (PAs) located within a 30-kilometer radius of all firm-operated polluting facilities, conditional on no government-managed PA, within the radius. In case all PAs within this radius are managed by a federal or local government agency in a given year, the variable takes the value of 0 in that year. This metric is scaled by the total area of designated PAs in the US, in the corresponding year.
$AbVolume[0,1]$	The difference between the average log dollar trading volume over the two-day window following the earnings announcement date and the average log dollar trading volume over the prior month. Daily dollar trading volume is calculated as the product of the daily closing price and the number of shares traded.
$AbSpread[0,1]$	The difference between the average daily bid-ask spread over the two-day trading window following the earnings announcement date and the average daily bid-ask spread over the prior month. The bid-ask spread is calculated as the difference between the offer price and the bid price, scaled by the midpoint of the two prices and multiplied by 100.
$AbsSUE$	The absolute value of earnings surprises.
$Treat$	Indicator variable equal to 1 if the firm is observed in a given quarter within a symmetric seven-year event window [-3,+3] surrounding its first exposure to protected areas located within a 30-kilometer radius of any of its facilities, and zero otherwise.
$Post$	Indicator variable equal to one for all quarters beginning with the first quarter in which the firm is first exposed to protected areas located within a 30-kilometer radius of any of its facilities, and zero otherwise.
$CBE\_Nonpolluting$	Firm-level exposure to protected areas is defined as the total surface area of protected areas (PAs) located within a 30-kilometer radius of each of the firm's nonpolluting facilities, aggregated across all polluting facilities and scaled by the total area of designated PAs in the U.S. in the corresponding year.
Random_AbRetn[0,1]	The size and book-to-market ratio-adjusted cumulative abnormal returns over the two-day trading window following a randomly assigned pseudo earnings announcement date within the same fiscal quarter.
AbRetn[-60,-1]	The size and book-to-market ratio-adjusted cumulative abnormal returns over the pre-announcement window.
AbRetn[2,60]	The size and book-to-market ratio-adjusted cumulative abnormal returns over the post-announcement window.
Low_SpeciesProtect	Indicator variable equal to one if the firm's headquarters is located in a state whose Species Protection Index is below the sample median, and zero otherwise.

Low_BioRating	Indicator variable equal to one if the firm's headquarters is located in a state whose biodiversity rating is classified as "major challenges," and zero otherwise.
Nonattainment	Indicator variable equal to one for firms headquartered in counties designated as nonattainment areas under the U.S. National Ambient Air Quality Standards.
Low_BioMedia	Indicator variable equal to one for firms headquartered in counties with biodiversity-related media coverage below the sample median.
Low_PopDensity	Indicator variable equal to one for firms headquartered in counties with population density below the sample median.
Biodiversity_Disc	Indicator variable equal to one if the firm discloses biodiversity exposure in 10-K filings and zero otherwise.
High_IO	Indicator variable equal to one if the firm's institutional ownership is above the sample median, and zero otherwise.
High_Analyst	Indicator variable equal to one if the firm's analyst coverage exceeds the sample median and zero otherwise.
High_Media	Indicator variable equal to one if the firm's media coverage is above the sample median.
High_NGO	Indicator variable equal to one if the firm is covered by the SigWatch database and zero otherwise.
Total_Plants	The natural logarithm of the total number of polluting plants operated by the firm in a given year.
ESG_Score	The combined ESG score of a firm in a given year.
EarnQuality	Discretionary accruals estimated using the modified Jones model (Dechow et al., 1995).
Climate Policy	US Climate Policy Index, obtained from Faccini et al. (2023), captures policy-related climate risk based on news coverage of U.S. climate policy actions and debates.
Climate Summit	International Climate Summit Index, obtained from Faccini et al. (2023), captures policy-related climate risk reflected in international climate negotiations and summits.
Global Warming	Global Warming Index, obtained from Faccini et al. (2023), measures physical climate risk related to global warming, proxied by news coverage of rising temperatures and long-term climate change trends.
Natural Disaster	Natural Disaster Index, obtained from Faccini et al. (2023), this index measures physical climate risk associated with extreme weather and natural disasters.

Appendix B
IUCN Protected Area Management Categories and Definitions

Category	Title	Definition / Management Objective
Ia	Strict Nature Reserve	Areas strictly set aside to protect biodiversity and/or geological features; human access and use are highly restricted, primarily for scientific research and monitoring purposes.
Ib	Wilderness Area	Large unmodified or slightly modified areas retaining natural character and influence; without permanent habitation and managed to preserve natural conditions.
II	National Park	Large natural areas set aside to protect ecological processes, species, and ecosystems; provide for spiritual, educational, scientific, and recreational uses.
III	Natural Monument	Areas set aside to protect a specific natural monument (e.g., landform, sea mount, cave, ancient grove); usually relatively small but of high conservation value.
IV	Habitat/Species Management Area	Areas aimed at protecting particular species or habitats, with management reflecting this priority; may require active interventions (e.g., habitat restoration, invasive species control).
V	Protected Landscape/Seascape	Areas where the interaction of people and nature has created a distinct landscape/seascape with ecological, cultural, and scenic value; management focuses on conservation and sustainable uses.
VI	Protected Area with Sustainable Use	Areas that conserve ecosystems and habitats together with cultural values and allow sustainable, low-level, non-industrial natural resource use.

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