The Value of Biodiversity Risk Disclosure [*]

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Abstract

Despite the critical role of natural ecosystems in the global economy and investors' rising attention on firms' exposure to biodiversity risks, disclosures about this risk exposure remain voluntary, unaudited, non-standardized, and sporadic, creating challenges for investors. Compared to the extensive literature on climate risk disclosures, studies on biodiversity risk disclosures are scarce. This paper measures voluntary biodiversity risk disclosure in annual reports using a two-step method that combines traditional natural language processing with advanced large language models (ChatGPT) and examines its impact on investor decision-making and biodiversity risk management. Our findings suggest that, while these disclosures are voluntary and often coarse, they appear to respond to investor and stakeholder demands for information and monitoring. Furthermore, they help investors assess firms' exposure to biodiversity risks, influence stock returns, and support effective risk management and sharing strategies.

Keywords: biodiversity risk; risk disclosure

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1 Introduction

The accounting profession, both in industry and academia, is placing increasing emphasis on the disclosure of climate change risk due to the growing recognition of its financial, regulatory, and environmental significance. Yet, climate risk is just one of the challenges for a sustainable global economy. Equally important, yet often overlooked, is the challenge of biodiversity conservation (Karolyi and Tobin-de la Puente, 2023). Biodiversity—the variety of life at the genetic, species, and ecosystem levels—is integral to the well-being of both society and the economy. Companies depend on healthy, diverse ecosystems: many medicines originate from plants and organisms in nature, the food and forestry industries rely on the natural environment, and biodiversity plays a key role in disease resilience and climate change adaptation. Furthermore, companies can face operational, regulatory, or reputational risks when they are perceived to harm ecosystems, such as in cases of oil spills, pollution, or wildfires linked to utility companies.

According to the UN Environmental Program and the World Economic Forum, more than half of the world's GDP—about $44 trillion—depends moderately or highly on natural ecosystems.[1] S&P Global estimates that 85% of companies rely significantly on natural resources and ecosystems for their operations.[2] Surveys of financial professionals, regulators, and academics indicate that around 70% of respondents believe biodiversity risks have at least moderate financial materiality for U.S. firms (Giglio, Kuchler, Stroebel, and Zeng, 2024).

Despite the rising attention to this risk, the disclosure of biodiversity risks by firms remains entirely voluntary and lacks standardized guidelines. Although there has been a growing trend in firms reporting such risks, these disclosures are often coarse due to the absence of regulatory mandates, auditing requirements, and consistent reporting standards. This raises concerns about the true informational value of these disclosures for investors. Recent developments in disclosure theory on risks suggest that investors face uncertainty in assessing firms' exposure

[1] World Economic Forum, 2020. Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Geneva: World Economic Forum. United Nations Environment Programme (2020). Global Biodiversity Outlook 5. Nairobi: UNEP.

[2] S&P Global, 2023. 2023 Sustainability Report: Natural Capital and Business Dependency. New York: S&P Global.

to systematic risks (Armstrong, Banerjee, and Corona, 2013). Consequently, in response to investors' information demand, firms have incentives to voluntarily disclose information related to their exposure to these risks if their exposure is substantial (Heinle, Smith, and Verrecchia, 2018; Schmalz and Zhuk, 2019). Such disclosures might help investors better evaluate each firm's exposure to biodiversity risk, incorporate this information into asset prices, and share and manage these risks more effectively by exchanging assets (Smith, 2023). This paper examines whether unaudited, non-standardized, voluntary biodiversity disclosure in firms' annual filings can create value for investors by facilitating assessment and sharing of biodiversity risk.

The voluntary nature of biodiversity risk disclosure and the lack of standardized reporting frameworks create significant measurement challenges. Disclosures are often dispersed across various sections of firms' reports and may lack a consistent format, making it difficult to accurately and consistently measure biodiversity risk exposure across firms. To address this challenge, we develop a two-step procedure that combines traditional natural language processing (NLP) techniques with advanced large language models (LLMs).

In the first step, we employ a baseline classification method using a traditional natural language processing (NLP) approach, based on a biodiversity-related keyword dictionary developed by Giglio, Kuchler, Stroebel, and Zeng (2024). According to this approach, a firm is classified as disclosing biodiversity risk if its 10-K statement includes at least two sentences that mention at least one keyword from the biodiversity dictionary. While this method aids in identifying sections of the 10-K that discuss biodiversity risk, it has two notable limitations. First, traditional NLP techniques may overlook crucial contextual information, focusing solely on sentences containing specific keywords. As a result, discussions about biodiversity risk might be present in surrounding sentences or be implied rather than explicitly stated, potentially leading to inaccurate assessments of a firm's risk exposure based solely on keyword counts. Second, traditional NLP methods struggle to capture the nuanced contextual information within the identified sentences. This limitation makes it challenging to determine the specific nature of the biodiversity risks discussed. For instance, it is difficult to discern whether the risk pertains to the firm's direct exposure, its exposure through the supply chain, physical risks related to ecosystem dependency, or regulatory risks associated with potential new biodiversity-related regulations that could impact future cash flows. Traditional NLP techniques are thus limited in their ability to fully comprehend and categorize the nature of the biodiversity risks discussed.

To overcome these limitations, we incorporate advanced LLMs, specifically ChatGPT, in the second step. For each biodiversity-related keyword identified in the first step, we extract 400 words before and after the keyword and prompt ChatGPT to assess the relevance of the information to biodiversity. ChatGPT classifies the types of biodiversity risk mentioned into the following categories: direct disclosure, indirect disclosure, and indirect exposure. *Direct Disclosure* involves explicit acknowledgment of biodiversity risks, clearly linked to the firm's business outcomes. For example, a mining company might disclose that new legislation on endangered species could significantly impact its operations. *Indirect Disclosure* includes discussions that suggest exposure to biodiversity risks without explicitly labeling it as such. For instance, an agricultural firm might note its dependence on land in biodiversity-prioritized regions. Finally, *indirect Exposure* pertains to risks related to the supply chain or value network, similar to Scope 3 emissions in carbon accounting. This category captures how biodiversity risks in a firm's supply-chain network affect its operations.

Our analysis, covering the period from 2001 to 2023, reveals substantial variability in the types of biodiversity risk disclosures over time. However, we observe a consistent increase in direct disclosures, reflecting growing environmental and biodiversity concerns. Specifically, the number of firms reporting biodiversity risks increased from 26 in 2001 to 114 in 2023, with direct disclosures rising most rapidly over the past two decades. To further understand the impact of these disclosures, we prompt ChatGPT to classify risks as either physical or regulatory. Physical risks refer to the direct effects of biodiversity loss on business operations. For example, a company reliant on agriculture might face reduced crop yields due to pollinator loss or habitat degradation. Regulatory risks, on the other hand, involve the potential consequences of stricter biodiversity-related regulations. For instance, a company could incur increased compliance costs or penalties if new regulations mandate habitat restoration or restrict activities harmful to ecosystems. Our findings show that regulatory risk disclosures have consistently been more prevalent than physical risk disclosures, with the former increasing at a faster pace over time.

With these newly measured firm exposures to biodiversity risks, we begin our empirical analysis by investigating potential determinants of biodiversity risk disclosures. Given that only a small fraction of firms disclose such risks, we form a cohort for each disclosing firm-year by pairing each disclosing firm with its 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016). This database identifies top competitors based on pairwise similarity scores derived from text analysis of 10-K product descriptions. Consequently, competitors are firm-year specific, with each firm-year having a unique set of rivals. In our study, we focus on the top 10 competitors for each disclosing firm annually, defining this group as the cohort. The rationale is that firms with similar production functions are likely to encounter comparable biodiversity risks. Thus, matching each biodiversity risk-disclosing firm with its closest product market peers enhances our statistical power to discern which firm characteristics are most strongly associated with disclosure decisions.

We first investigate whether larger firms and those with a higher proportion of institutional investors are more likely to voluntarily disclose biodiversity risks, given the increased demand for such information from these investors. Our analysis reveals a positive and significant relationship between firm size and biodiversity disclosure, as well as between institutional investor ownership and disclosure. This indicates that firms with greater institutional ownership are more inclined to report biodiversity risks, reflecting the rising importance of biodiversity transparency to institutional investors. Conversely, we find a significant negative relationship between the concentration of institutional investor ownership, as measured by the Herfindahl-Hirschman Index (HHI), and biodiversity disclosure. This suggests that while broad institutional ownership promotes reporting, a more concentrated ownership structure may reduce disclosure likelihood, aligning with the idea that diverse ownership demands higher scrutiny and information transparency.

We then examine CEO characteristics. Prior research indicates that firms with new CEOs are more likely to undertake significant actions and issue climate disclosures (e.g. Gabarro, 1987; Hambrick and Fukutomi, 1991). Our findings similarly show that firms with new CEOs are more likely to disclose biodiversity risks. Notably, we observe a significant negative relationship between the CEO's legal background and the likelihood of disclosing biodiversity risks. This suggests that CEOs with legal expertise may be in a better position to handle litigation risks and thus less inclined to use disclosure as a preemptive measure. To explore this further, we analyzed securities class action lawsuits from Standard Law School, focusing on broader sustainability issues due to the limited number of biodiversity-related cases. We find that firms with a history of sustainability-related litigation are more likely to disclose biodiversity risks. This indicates that litigation risk may drive transparency in sustainability and biodiversity reporting as a defensive strategy to mitigate future legal risks.

In the absence of disclosure mandates, a firm's voluntary disclosure decisions are often influenced by its peers (Lin, Mao, and Wang, 2018; Seo, 2021). We thus examine how the disclosure practices of a firm's direct competitors affect its own disclosure decisions. For each firm in our sample, we determine the number of direct competitors that disclosed biodiversity risk in the same year. Our results reveal that the presence of an additional competitor disclosing biodiversity risk increases the likelihood that the focal firm will also disclose such risks. Beyond investor and peer influence, local residents and nonprofits can also impact a firm's biodiversity disclosure. Unlike abstract issues such as carbon emissions, biodiversity is often more tangible and noticeable to local communities, particularly when it affects their immediate environment. Prior research on stakeholder engagement shows that firms are responsive to localized pressures, especially when these are visible and proximate (Deegan, Rankin, and Tobin, 2002; Marquis, Glynn, and Davis, 2007). To assess these localized pressures, we use establishment-level data from the Your-economy Time Series (YTS) dataset to measure exposure to biodiversity-related risks. We aggregate public pressure at the establishment level to the firm level, weighting by the number of employees at each establishment. We find that firms are more likely to disclose indirect impacts of biodiversity risk in response to local biodiversity-related protests.

Interestingly, we observe that firms are less likely to use biodiversity-related keywords when environmental protests are prevalent in their operational areas. This suggests that constructive environmental efforts may diminish the urgency or perceived need for biodiversity disclosures. To further investigate local attention and scrutiny, we analyze Google Trends data to gauge public interest in biodiversity at the metropolitan area level, aggregating this index to the firm-year level and weighting by the number of employees. Our findings indicate a positive relationship between local interest in biodiversity captured by Google search of biodiversity-related issues and the likelihood of firms' disclosures related to indirect impacts, indirect exposure, and regulatory biodiversity risks. Overall, our findings suggest that visible public dissent and attention can drive voluntary disclosure and align with the literature on the influence of external stakeholder pressures on corporate transparency.

Our results so far suggest that biodiversity risk disclosure responds to investor and stakeholder information and monitoring demands, raising the question of whether such voluntary disclosures offer genuine informational value beyond mitigating potential litigation and protests. To address this, we examine whether such voluntary disclosures help investors better assess a firm's exposure to biodiversity risk. We estimate each firm's perceived biodiversity risk exposure (i.e., perceived biodiversity Beta) as the firm's stock return sensitivity to the New York Times Biodiversity Index, as developed by Giglio, Kuchler, Stroebel, and Zeng (2024). This index reflects media sentiment through the number of negative minus positive biodiversity articles on a given day, with higher values indicating more negative sentiment. It thus captures fluctuations in biodiversity risks at the market level. A firm's annual perceived biodiversity Beta is estimated as its weekly excess stock return sensitivity to the biodiversity news index in a year. This estimate captures investors' assessment of firms' biodiversity risk exposure as reflected in stock returns, in contrast to firms' disclosed biodiversity risk exposure that we measure from firms' annual reports.

We first analyze whether voluntary biodiversity risk disclosures aid investors in updating a firm's perceived biodiversity Beta. If disclosures are primarily from firms with underestimated biodiversity Beta, we expect the Beta to increase post-disclosure. These firms might have private negative information about their exposure and disclose it to preempt potential litigation. Conversely, if disclosures come from firms with overestimated biodiversity Beta, we would expect the Beta to decrease. Such firms, which may face higher risk premiums due to perceived high exposure, have an incentive to correct investors' perceptions by revealing their actual risk and management practices. Finally, if biodiversity disclosures provide minimal insight into firms' true risk exposure, we would not expect investors to adjust their evaluation of a firm's biodiversity Beta based on these disclosures.

Nest, we conduct an event study to assess how a firm's perceived biodiversity Beta changes over a seven-year window around the first year of biodiversity risk disclosure in the annual report. Firms that disclose are compared to closely matched non-disclosing competitors. Our findings reveal that, while a disclosing firm's biodiversity Beta remains stable before the initial disclosure, it significantly decreases in the year following the disclosure and remains lower in subsequent years. Although causality cannot be established due to the voluntary nature of disclosures, the results suggest that investors adjust their assessment of a firm's biodiversity Beta downwards in response to such disclosures.

Our results indicate that investors adjust their assessments of biodiversity risk Betas following disclosures. If this disclosure-induced adjustment leads to more accurate evaluations of firms' biodiversity risk exposure, the disclosure should contain useful information for investors to hedge biodiversity risk. In other words, if we measure firms' biodiversity risk exposure with their relevant disclosures, we would expect stock returns for firms with higher exposure to decline when aggregate biodiversity risk shocks occur. To test this hypothesis, we regress the excess returns of disclosing firms on the interaction between disclosure-based biodiversity risk exposure measures and aggregate biodiversity risk shocks, i.e., the AR(1) residuals of the New York Times Biodiversity News index. The significantly negative coefficient for this interaction term suggests that firms with higher disclosed biodiversity risk exposure experience a decline in stock prices when aggregate risk shocks materialize, supporting the idea that biodiversity risk disclosures provide relevant information about firms' sensitivity to aggregate biodiversity risk.

In our final test, we evaluate whether investors can use such disclosures to manage and share aggregate biodiversity risk by employing the hedging portfolio strategy proposed by Engle, Giglio, Kelly, Lee, and Stroebel (2020). Our findings confirm that a hedging strategy—going long on industries with more biodiversity risk exposure disclosure and shorting industries with less disclosure—yields positive returns when systematic biodiversity risks materialize. This positive correlation between portfolio returns and aggregate biodiversity risk shocks indicates that portfolios formed based on biodiversity risk disclosures effectively hedge and share biodiversity risks. Overall, our findings suggest that biodiversity risk disclosures offer valuable information on firms' risk exposures and can assist investors in managing and mitigating these risks, aligning with Smith (2023)'s theoretical predictions.

Our paper makes two contributions to the literature. First, our research contributes to the growing literature on the impact of risk exposure disclosure on asset prices. On the theoretical side, Heinle, Smith, and Verrecchia (2018) explore how risk exposure disclosure reduces investor uncertainty about a firm's risk, thereby influencing asset prices. Schmalz and Zhuk (2019) demonstrate that investors' learning about firms' risk exposures through earnings can lead to increased volatility during downturns and skewness in returns. Smith (2024) examines how risk disclosure affects information acquisition and the feedback loop between prices and investment decisions. Particularly relevant to our study, Smith (2023) shows that, in the presence of short-sale constraints, climate risk disclosure enhances market efficiency by enabling more precise risk sharing, as investors use better information to construct effective climate hedging portfolios.

Empirically, Smith and So (2022) measures the presence and timing of firm-specific risk-related information, while Lyle, Riedl, and Siano (2023) documents that risk exposure disclosure reduces uncertainty about firms' idiosyncratic risk. Our study extends this line of research by providing new empirical evidence on how investors leverage firms' voluntary biodiversity risk disclosures in annual reports to update their assessments of firms' exposure to aggregate risks.

Additionally, we demonstrate how these disclosures facilitate risk management and sharing by enabling investors to build hedging portfolios in response to aggregate biodiversity risk shocks.

Second, our paper develops a novel two-step procedure that combines traditional NLP tools with LLMs to measure biodiversity risk exposure. As global economic activity increasingly depends on natural ecosystems, risks related to biodiversity loss remain poorly understood. Reliable measurement of biodiversity risk disclosures is essential for investors to accurately assess firms' exposure and make informed decisions. However, the voluntary and non-standardized nature of biodiversity risk disclosures presents significant challenges. These disclosures are often scattered across various sections of firms' reports and lack uniformity, making it difficult to consistently capture biodiversity-related risks. Our two-step procedure overcomes these challenges, allowing us not only to measure biodiversity risk disclosures more accurately but also to classify the type of biodiversity risk—whether it pertains to direct disclosure, indirect disclosure, or indirect exposure. This enhanced methodology allows for a deeper understanding of the specific risks firms face, whether from direct operations or through their supply chains, ultimately providing a more comprehensive assessment of biodiversity risks for investors.

2 Data

2.1 Biodiversity Disclosure Classifications

Our baseline classification of whether a firm discloses biodiversity risk in the 10-K statement is based on the biodiversity-related keyword count constructed in Giglio, Kuchler, Stroebel, and Zeng (2024). They constructed a Biodiversity Dictionary with 100 words based on the cosine similarity using Google's *word2vec* implementation and identified sentences related to biodiversity using regular expressions. Following their approach, we define that a firm discloses biodiversity risk if a 10-K statement contains at least two sentences with biodiversity-related keywords defined by Giglio et al. (2024). In our sample, 114 firms discussed biodiversity in their 10-K statement in 2023, and about 4.2% of US firms disclosed biodiversity risk since

2015. Figure A1 in the Appendix presents a word cloud of the top 200 words in paragraphs of the 10-K statements that contain biodiversity-related keywords.

Disclosure Risk Types. Within the 10-K statements of firms that disclose biodiversity risk, there are considerable variations in their reported exposure to and impact of biodiversity risk because of the lack of regulatory guidelines or requirements on biodiversity risk disclosures. Hence, as an initial and novel effort, we consider three different types of biodiversity risk when analyzing firms' discussions related to biodiversity risk: direct disclosure, indirect disclosure, and/or indirect exposure.

The first category, "Direct Disclosure," refers to the self-disclosed risk, which means that the company explicitly acknowledges the biodiversity risk and that the risk is clearly recognized as a potential threat to the company's business or value. The key indicator is that the disclosure provides a direct link between biodiversity risks and business outcomes. For example, a mining company can provide such disclosure if it explicitly mentions that new legislation requiring stricter protection of endangered species, such as the Endangered Species Act, in their operational areas, could significantly increase compliance costs and restrict their business expansion.

The second category, "Indirect Disclosure," captures the business-relevant risk. This is the case when a company does not explicitly state its exposure to biodiversity risk in its 10-K disclosure, but the discussion of its business model or strategy implies an exposure to such risk. In other words, even though the risk is not explicitly mentioned in its reporting, the firm recognizes the importance of ecosystems or natural resources to its operations. For example, an agricultural company notes that its operations rely on extensive land use in regions where biodiversity conservation is increasingly prioritized.

The last category, "Indirect Exposure," is the upstream/downstream exposure to biodiversity risk. This involves indirect exposure to biodiversity risks through the supply chain, partners, or customers rather than the company's direct operations. The idea of this category is similar to Scope 3 emissions in carbon accounting – the company's exposure to biodiversity risk is through the biodiversity risk exposure of other companies in its value chain or network.

We use ChatGPT 4o to assess the relevance of the disclosed information to biodiversity and classify the types of biodiversity risks the firm faces. For each 10-K statement with the biodiversity-related keyword, we extracted 400 words before and after it[3]. If there are multiple mentions in a single statement, we combine all the discussions without repeated sentences along with our prompt explaining the classifications. We let ChatGPT provide a score on a scale from 0 to 1 indicating the likelihood that the disclosure is related to each of the three categories and explanations for the decision. Tables A1, A2, and A3 in the Appendix show additional examples of direct disclosure, indirect disclosure, and indirect exposure in 10-K statements with ChatGPT explanations.

Figure 1 shows the average probabilities of the three disclosure risk types from 2001 to 2023. There exist relatively large fluctuations in all of the three types across years. However, we could observe a steadily increasing trend in the self-disclosure risk or so-called direct disclosure across the years, which is consistent with the rising concerns in the environment and biodiversity-related issues.

Physical vs. Regulatory Risk. Many data vendors provide ratings and scores for regulatory and physical risk when differentiating firms' climate risk. To have a better understanding of firms' biodiversity discussions and potential financial impact, we also classify whether the discussion is related to physical or regulatory risk. Physical risk refers to the potential negative effects on a company's business or value due to deteriorated biodiversity. The regulatory risk involves potential negative impacts due to stricter regulations aimed at biodiversity protection. As shown in Figure 2a, the average probability of regulatory and physical risk disclosure in the 10-K statements between 2001 and 2023 shows a consistent trend. Firms report regulatory risk more frequently than physical risk across the years. However, physical risk disclosures exhibit a slight upward trend over time. These suggest that while firms may be more aware of regulatory

[3]We used the list of Biodiversity Dictionary based on the prior 2023 May version of Giglio, Kuchler, Stroebel, and Zeng (2024): *biodiversity*, *ecosystem(s)*, *ecology*, *ecological*, *habitat(s)*, *species*, *forest*, *rainforest(s)*, *deforestation*, *fauna*, *flora*, *marine*, *tropical*, *freshwater*, *wetland*, *wildlife*, *coral*, *aquatic*, *desertification*, *carbon sink(s)*, *ecosphere*, and *biosphere*.

or transitional pressures, attention to the direct physical impacts of diversity biodiversity loss on business operations is gradually increasing. Additional examples of physical and regulatory risk disclosure in 10-K statements are in the Appendix.

Natural Capital. Firms' exposure to diversity risk is inherently tied to their interaction with various forms of natural resources. Using the natural capital classification from the MSCI biodiversity research report[4], we categorize the biodiversity risk disclosure based on the relevance to key natural resources, including land, species, oceans, habitat, water, atmosphere, soil, and minerals. This classification may potentially be easier to quantify and measure than the other dimensions, and it allows us to more precisely identify the specific environmental dimensions that firms are addressing in their biodiversity risk disclosures.

Based on all the categories we introduce to differentiate the biodiversity risk disclosure, a natural question is how correlated the different classifications are. Table 1 presents the firm-level correlation between each two classification variables.

2.2 Other Firm and Biodiversity Data

Extensive research has examined the firm-specific factors that influence corporate social responsibility (CSR), environmental, social, and governance (ESG), and sustainable reporting. Christensen, Hail, and Leuz (2021) provided a comprehensive review of the key determinants of voluntary CSR reporting. Some of the key factors include firm size and revenue (e.g., Hahn and Kühnen, 2013), institutional ownership (e.g., Höllerer, 2013; Cormier and Magnan, 1999; Cormier et al., 2005), governance structure such as the number of directors on the board and number of board meeting (e.g., Dalla Via and Perego, 2018), and management characteristics such as education background (e.g., Lewis et al., 2014), gender ratio (e.g., Marquis and Lee, 2013; Borghesi et al., 2014) and board nationality (e.g., Haniffa and Cooke, 2005).

Following the prior literature, we obtained firm characteristics from Compustat and institutional ownership data from Thomson Reuters. Specifically, we compute the percentage of

[4] MSCI, 2021

institutional ownership as the total institutional ownership divided by the total shares outstanding, and the Herfindahl-Hirschman Index (HHI) of investor ownership to measure the ownership concentration.

For governance and management characteristics, we used the individuals' education and employment and organizations' analytics data from Boardex. In terms of education, we focused on whether the CEOs and managers have an MBA and/or legal degree. For MBA, we account for any qualification that contains the relevant keyword such as "MBA", "Professional MBA (PMBA)" and "Executive MBA". For legal degrees, we account for any qualification that contains MLS, LLM, JD, or master of legal studies, master of laws, juris doctor, e.g., "Global Professional Master of Laws (GPLLM)" and "Executive JD (EJD)". We did not focus on other education degrees because most of the degrees are listed as B.A./B.S. and more granular information such as an engineering degree does not have sufficient observations.

Since most CEOs take major actions within the first two and a half years of office (Gabarro, 1987; Hambrick and Fukutomi, 1991), we also construct a dummy variable of whether a CEO has been in the office for less than three years from the date of appointment to the annual report date. Other managing characteristics such as gender ratio and board nationality mix are calculated as the proportion of male directors and the proportion of directors from different countries on the annual report date.

Litigation risk is a frequently discussed explanation of why firms voluntarily disclose climate and environmental issues in their 10K filings. We obtained the Securities Class Action Clearinghouse (SCAC) filing database from Stanford Law School with over 6,500 lawsuits filed since the passage of the Private Securities Litigation Reform Act of 1995. In cases of federal security law violations, it is common for issuers, underwriters, investment banks, brokerage firms, mutual funds, or a combination of these to face multiple complaints and lawsuits, each filed by different plaintiffs and represented by various law firms. Thus, a single record in the SCAC refers to one or more securities class action complaints based on the same allegations against the same defendant or group of defendants.

To identify biodiversity-related cases, we searched for the keywords of the Biodiversity Dictionary in the texts of allegations and complaints. Given the concern about the limited sample size of biodiversity-specific lawsuits for statistical testing, we broaden our analysis to include lawsuits related to sustainability and environmental issues. We thus additionally incorporated climate-related keywords from the climate dictionary constructed by Giglio, Kuchler, Stroebel, and Zeng (2024).

In addition to the firm-level characteristics, one of our hypotheses is that the local residents and nonprofits would pressure firms to disclose their biodiversity risk exposure. We obtained environmental and biodiversity protests from the Crowd Counting Consortium (CCC) which provides political crowd data in the United States by Harvard Kennedy School and the University of Connecticut. It contains detailed crowd data on the protest size, injuries of the crowd and police, estimated property damage, arrests, and protest descriptions on the county level since 2017. We used the same list of biodiversity keywords to identify biodiversity-related protests based on the claims and issues of the protest descriptions. To have a direct comparison to attention on the climate and environmental issues, we also use regular expression searches for actions with environment and climate keywords to identify environmental protests.

Another data we used to capture local attention on biodiversity is the Google search index. Specifically, we obtained the metropolitan-area-level Google trend index on the topic of "biodiversity" using Google Trends API. The Google index is on a scale of 0-100 on the metropolitan city level[5]. As robustness, we also construct an alternative biodiversity search index that sums up the search index series for "biodiversity loss", "ecosystem services", and "species loss" in each time period used in Giglio, Kuchler, Stroebel, and Zeng (2024)'s paper.

To construct the firm-level local pressure measures, we obtained the Your-economy Time Series (YTS) from 1997 to 2018 with establishment-level data for all privately owned, publicly traded, nonprofit, and government establishments across the U.S. The YTS provides annual data on sales, employment, coordinates, and headquarters information. We used the avail-

[5]We used the crosswalk dataset created by Jacob Schneider that maps the Google Trends' metro areas to counties. We define that an establishment has 0 attention if its county has an NA value.

able ticker information of headquarter establishments in the YTS dataset and applied spatial matching and fuzzy name matching to merge the YTS dataset with CRSP/Compustat to identify establishments of publicly traded firms. For firm-year level measures, we aggregate local protests and Google search trends based on the county location of the establishments. All the aggregated variables are weighted by the number of employees at each establishment to capture the relative importance of each location within the firm's overall operations.

3 Determinants of Biodiversity Disclosure

With the newly constructed biodiversity risk exposure disclosure variables, we begin by examining the factors that might influence a firm's decision to disclose this information. Given that only a small proportion of firms disclose biodiversity, we match each disclosing firm with its top competitors in the same year to have a direct and meaningful comparison. Hoberg and Phillips (2016) identified top competitors for each firm based on firm pairwise similarity scores from text analysis of firm 10K product descriptions. Thus, competitors are firm centric with each firm having its own distinct set of competitors. We focus on the top 10 competitors for each disclosing firm-year and define them as a cohort. Our main analyses are on the cohort level with the following specification:

$$Disclose_{i,t} = X_{i,t} + \alpha_c + \epsilon_{i,t} \tag{1}$$

where each cohort contains a firm i that disclosed in year t with its top 10 competitors that did not disclose as the control group. $X_{i,t}$ is a list of explanatory variables that may explain firms' disclosure based on past literature discussed previously. The outcome variable is a list of dummy variables of whether a firm has disclosed biodiversity risk based on whether the statement contains at least two sentences with biodiversity-related keywords, and three other GPT-based disclosure classifications introduced in the data section.

3.1 Firm Characteristics and External Pressure

One important question is whether the key determinants from the CSR and sustainable reporting literature can help explain voluntary disclosure of biodiversity risk.

Table 2 presents the baseline results of the relationship between firm characteristics and biodiversity risk disclosure. We find internal factors such as firm size, whether the CEO has been in the office for less than three years, and the proportion of non-US managers on the board are positively associated with biodiversity reporting. A positive coefficient on the size variable suggests that larger firms may receive greater public scrutiny such that they are more motivated to report any potential biodiversity risk, similarly to CSR reporting (e.g., Cormier and Magnan, 2003; Thorne et al., 2014). It is also possible that biodiversity risk shares many similar characteristics of CSR and hence is less costly for larger firms than smaller firms to communicate the biodiversity risk just as CSR communication (Wickert, Scherer, and Spence, 2016). If CEOs are relatively new, their firms are more likely to take major actions (Gabarro, 1987; Hambrick and Fukutomi, 1991) and hence consistent with the prior findings on the climate disclosure, firms with new CEOS are also more likely to disclose biodiversity risk.

We also examined whether external factors, specifically institutional investors' ownership, affect firms' likelihood of disclosing biodiversity-related risks in their 10K filings. Prior studies have shown that institutional investors can exert pressure on firms to engage in CSR reporting to better align with their preferences (e.g., Dhaliwal et al., 2011; Solomon et al., 2011; Pawliczek et al., 2021). We find a positive and significant relationship between the proportion of institutional investor ownership and biodiversity disclosure. This suggests that firms with higher institutional ownership are more likely to report biodiversity risks, potentially reflecting the growing attention and importance of biodiversity transparency to institutional investors. Nevertheless, interestingly, we also identify a significant negative relationship between institutional investor concentration, as measured by the HHI of ownership, and biodiversity disclosure. This suggests that while broad institutional ownership promotes biodiversity reporting, a more concentrated ownership structure might reduce the likelihood of such disclosures and diverse ownership may demand higher information transparency.

Columns (1)-(3) in Table 3 present estimated effects of firm characteristics and institutional ownership on the likelihood of firms directly disclosing, indirectly disclosing, or being indirectly exposed to biodiversity risk. Columns (4)-(5) examine whether firms disclose physical and/or regulatory risk, and columns (6)-(13) show the relevance of different natural capital to firms' disclosure. For all binary outcome variables, we applied a threshold of 0.5, assigning a value of 1 to a firm's disclosure dummy if ChatGPT classified the probability of the direct disclosure as greater than or equal to 0.5. As a robustness check, we tested alternative thresholds and ran logit regressions in the Appendix and our results are consistent across specifications.

The findings presented in Table 3 are largely aligned with those in the baseline regressions. A particularly interesting finding is the significant negative relationship between the CEO holding a legal degree and the firm's likelihood of disclosing biodiversity risks. This result suggests that legal expertise at the executive level may influence firms' disclosure strategies, potentially due to heightened attention to and awareness of biodiversity-related regulatory risks. To further explore this mechanism, we obtained data on securities class action lawsuits from Standard Law School. Given the limited sample of biodiversity-related lawsuits on the record to make a meaningful statistical test, we focus on identifying cases related to not only biodiversity issues but also a broader category of sustainability issues with environmental and climate-related keywords. In Table 4, we examine whether firms with more past litigation are more likely to disclose biodiversity risks on biodiversity.

The prior empirical literature on shareholder litigation and corporate disclosure has found mixed findings, with some studies indicating that litigation risk can deter disclosure (e.g., Johnson et al., 2001; Baginski et al., 2002; Bourveau et al., 2018), while others suggest it may encourage greater transparency to mitigate potential legal exposure (e.g., Naughton et al., 2019; Houston et al., 2019). Our results in Table 4 contribute to the debate by providing evidence that firms facing more sustainability-related lawsuits are more likely to disclose biodiversity risks. This suggests that litigation risk may promote transparency, particularly in areas of sustainability and biodiversity uncertainty, as a defensive mechanism to mitigate future legal risks. However, our findings also indicate that CEOs with legal expertise may be more conservative and choose to limit disclosures to avoid potential liabilities. This dynamic indicates the potential trade-offs that firms face in navigating regulatory compliance, risk exposure, and strategic disclosure decisions.

In addition, peer effects and competitor dynamics particularly regarding voluntary disclosure have been extensively studied (e.g., Seo, 2021; Lin et al., 2018). We thus also explore an important external factor that may affect a firm's decision to disclose biodiversity risk: the disclosure practices and decisions of its direct competitors. For each firm in our data sample (firms that disclose and their top competitors that do not disclose), we calculate how many of their direct competitors disclosed biodiversity risk in the same year. The results in Table 5 show that an additional direct competitor that discloses biodiversity risk in the 10K statement will motivate the firm to disclose the risk as well[6]. This suggests that peer pressure has a significant and positive impact on increasing the transparency of a firm's 10K filings.

3.2 Local Pressure

Pressure from local residents, nonprofits, and government entities can drive variations in firms' climate and biodiversity disclosures. Unlike carbon emissions, which may be more abstract for the general public, biodiversity is often more tangible and noticeable to local residents, especially when it directly impacts their surrounding environment. Prior literature on stakeholder and local community engagement has shown that firms often respond to localized pressures, especially when these pressures are visible and proximate (e.g., Freeman, 2010; Marquis et al., 2007; Deegan et al., 2002). In the context of biodiversity, such pressures may manifest more prominently as local residents demand transparency and accountability regarding how firms' operations impact local ecosystems and natural resources.

[6]We control for firm and year fixed effects instead of cohort fixed effects in order to make a fair comparison. Otherwise, since most firms do not disclose, including cohort fixed effects would mechanically make a negative relation between the number of disclosing competitors and whether or not the firm discloses.

To capture these localized pressures, we use establishment-level data from the Your-economy Time Series (YTS) dataset to measure firms' exposure to biodiversity-related risks. We aggregate public pressure at the establishment level to the firm level, weighting by the number of employees at each establishment. Since our YTS sample ends in 2018 and the CCC data begins in 2017, we use data from these two years to assess whether local protests can explain firms' biodiversity disclosure.

As shown in Table 6, firms are more likely to discuss how their business operations may be indirectly affected by biodiversity risk when local protests related to biodiversity issues occur. This finding suggests that visible public dissent can motivate voluntary disclosure and is consistent with the literature that external stakeholder pressures shape corporate transparency. On the other hand, we find that firms are less likely to mention biodiversity-related keywords when environment-related protests are prevalent in the counties where their establishments are located, indicating that constructive environmental efforts may reduce the urgency or perceived need for biodiversity disclosures.

To further assess the impact of local attention, we use Google Trends data to measure public interest in biodiversity at the metropolitan area level. We again aggregated the index to the firm-year level weighted by the number of employees. The results in Table 7 show a positive relation between the local residents' attention to biodiversity and the likelihood of firms' indirect disclosure, indirect exposure, and regulatory risk. Thus, overall, our results indicate that heightened attention and visible public opposition can motivate voluntary disclosure of biodiversity risk.

4 Biodiversity Risk Exposure

Our results suggest that biodiversity risk disclosure is responsive to information demands and potential monitoring expectations from investors and other external stakeholders. This raised an interesting and important question: Does voluntary disclosure provide informational value to investors such that they can better assess a firm's exposure to biodiversity risk? Specifically, we examine whether firms' voluntary biodiversity risk disclosures enable investors to update their perceptions of the firm's exposure to biodiversity risks.

We measure each firm's aggregate biodiversity risk exposure using a firm-year-level Beta derived from the New York Times (NYT) Biodiversity News Index. Giglio, Kuchler, Stroebel, and Zeng (2024) constructed this news index by analyzing daily articles in the NYT and classifying the sentiments using BERT. The daily news index is the number of negative biodiversity articles minus the number of positive biodiversity articles on a given day. The higher the index, the more negative the media sentiment is. We estimate investors' perceived firm-specific Betas through the following specification:

$$r_{i,y,t} = \beta_{i,y} BiodiversityNewsIndex_{y,t} + X_{y,t} + \epsilon_{i,y,t}$$

where t represents the week, the Beta $\beta_{i,y}$ captures the sensitivity of firm returns to changes in biodiversity-related news sentiment, $BiodiversityIndex_{y,t}$ is the sum of the news index in each week, and we include Fama and French 3 factors. For robustness, we also try using the CAPM, Carhart 4-factor, Fama and French 5-factor models. This biodiversity Beta captures investors' assessment of firms' biodiversity risk exposure as reflected in stock returns (i.e., perceived biodiversity risk exposure), in contrast to firms' disclosed biodiversity risk exposure that we measure from firms' annual reports

To explore the dynamic effects of biodiversity disclosures on the perceived biodiversity risk exposure, we conduct an event study analysis using the same set of disclosing firms and their top direct competitors with the following specifications.

$$Beta_{i,t} = \sum_{\tau=-4,\tau\neq-1}^{3} \beta_\tau Disclose_{i,\tau} + X_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t} \tag{2}$$

In the equation, $Disclose_{i,\tau}$ equals 1 if $t - \tau_i^* = \tau$, where τ_i^* is the year a firm i discloses the biodiversity risk. We normalize the effect in the year before the disclosure ($\tau = -1$) to zero. Control variables $X_{i,t}$ include size, revenue, institutional investors' ownership, and ownership concentration as measured by the HHI. To capture differential biodiversity disclosure, we employ the keyword-based classification and a set of disclosure type classifications using ChatGPT, i.e., whether a firm directly or indirectly discloses biodiversity risk or is indirectly exposed to it. Additionally, we also construct the variable ChatGPT Disclose$_{i,t}$, which equals 1 if any of the classifications–direct disclosure, indirect disclosure, and indirect exposure classifications – are true, indicating that the firm has addressed biodiversity risk in its disclosures instead of simply mentioning keywords without further implication of facing potential biodiversity risk.

The event study results, illustrated in Figure 3, suggest that firms' perceived biodiversity risk exposure, as measured by biodiversity Beta, significantly decreases following voluntary disclosure of biodiversity risks. This reduction is most pronounced in the first year after disclosure and remains low in subsequent years, indicating that voluntary disclosures may have a lasting impact on how investors perceive firm biodiversity risk. In contrast, as shown in Figure 3a, there is no statistically significant impact on risk exposure if the firms just mention the biodiversity risk without providing substantive details. However, when firms disclose concrete exposure to biodiversity risk in their business, particularly indirect exposure or regulatory risks, the perceived risk exposure would decrease significantly.

Although our research does not seek to establish the causal relationship between voluntary disclosure and investors' perceived changes in risk exposure, as the decision to disclose is not random, the results suggest that investors adjust their evaluations of a firm's biodiversity risk downwards in response to meaningful disclosures. This aligns with the prior findings on the impact of CSR disclosure, which posits that investors incorporate new information into their risk assessments when firms provide detailed, credible insights into their risk exposure (e.g., Dhaliwal et al., 2011).

The observed decrease in risk exposure suggests that voluntary disclosure may offer informational value to investors and allow them to better assess a firm's exposure to biodiversity risk. A plausible explanation is that firms operating in industries with high biodiversity risk exposure, and thus facing higher required risk premiums from investors, are more incentivized to disclose their actual exposure and risk management practices. By doing so, these firms may seek to reduce the perceived uncertainty about their risk exposure, ultimately lowering their Betas.

5 Hedging Portfolios

The findings on adjustments in risk exposure following biodiversity risk disclosure suggest that such voluntary disclosures may lead to more accurate evaluations of firms' biodiversity risk exposure. Since the adjustment, which leads to more accurate evaluations of firms' biodiversity risk exposure, is driven by relevant disclosures, these disclosures should contain useful information for investors to hedge biodiversity risk. Therefore, we expect stock returns for firms with higher biodiversity risk exposure, measured by the disclosure of such risk, to react more sensitively to aggregate biodiversity risk shocks. Specifically, firms with greater disclosure-based biodiversity risk exposure should experience larger declines in stock returns when negative biodiversity events occur.

To test this hypothesis, we regress the excess returns of firms that disclosed biodiversity risk on the interaction between their disclosure-based biodiversity risk exposure measures and aggregate biodiversity risk shocks, using the following specification.

$$\begin{aligned} ExcessRet_{i,t} =& \beta_1 Exposure_{i,t-1} + \beta_2 BioNewsInnovation_{t-1} \times Exposure_{i,t-1} \\ &+ X_{i,t} + \alpha_t + \alpha_i + \epsilon_{i,t} \end{aligned} \tag{3}$$

where $Exposure_{i,t-1}$ represents the set of disclosure classifications, including whether the firm's 10K statements contain at least two sentences with biodiversity-related keywords, whether the firm directly or indirectly discloses the biodiversity risks, or is indirectly exposed to them, and whether the firm has physical and/or regulatory risks. $ExcessRet_{i,t}$ is the excess return of each firm's returns in each time period. $BioNewsInnovation_{t-1}$ refers to the innovations in the biodiversity news index, where we calculate the monthly values by averaging the daily values of the NYT Biodiversity News Index within each month and then compute the residuals from a monthly AR(1) model. In addition to firm and year-by-month fixed effects, we also include industry-year fixed effects to account for variations in biodiversity risk exposure that may be specific to certain industries in a given year.

The results in Table 8 show a statistically significant negative relation between the interaction of risk exposure and aggregate biodiversity risk shocks and firms' excess returns. This indicates that firms with higher disclosed biodiversity exposure experience a decline in stock prices when aggregate risk shocks occur, supporting the idea that biodiversity risk disclosures provide valuable information about firms' vulnerability to aggregate risk. Interestingly, this negative effect is relatively more pronounced when the exposure stems from regulatory risks or direct disclosures, suggesting that investors may perceive these types of disclosures as particularly credible or material to a firm's risk profile.

Lastly, we assess whether investors can use biodiversity risk disclosures to manage and hedge aggregate risks by employing the hedging portfolio strategy proposed by Engle, Giglio, Kelly, Lee, and Stroebel (2020). Prior research (e.g., Giglio et al., 2024; Garel et al., 2024; Kalhoro and Kyaw, 2024) has demonstrated that biodiversity risk has been increasingly priced in equity markets in recent years. If biodiversity risk is indeed priced, then the value of portfolios sorted by biodiversity exposure should fluctuate with biodiversity-related news. Specifically, the returns on these portfolios would co-move with the biodiversity news index, similar to how hedging portfolios respond to aggregate risk shocks. We therefore construct hedging portfolios to test whether voluntary disclosures have informational value and then further examine which types of biodiversity disclosures offer the most effective hedge against biodiversity risk.

We construct six different hedging portfolios based on various risk exposure measures, including keyword mentions, direct disclosure, indirect disclosure, indirect exposure, physical risk, and regulatory risk. To build these portfolios, we aggregate exposures at the industry level using 24 four-digit GICS industries. For each portfolio, we take long positions in firms with low biodiversity risk exposure, as indicated by our 10-K-based measures, and short positions in firms with high biodiversity risk exposure. The intuition is that firms with low biodiversity risk measures are less likely to be negatively impacted—or may even benefit— from the realization of biodiversity risks, whereas firms with high biodiversity risk exposure are more likely to be negatively affected when biodiversity risks materialize.

Each portfolio is constructed by aggregating firm-level exposures to the industry level, weighted by the firm's market capitalization. The portfolio weights are based on each industry's biodiversity risk exposure percentile within the overall industry distribution. To maintain a zero net position in each period, we long the lower half of industries (those with lower biodiversity risk exposure) and short the upper half (industries with higher exposure), and thus industries with the median biodiversity score are not held. In each period, we calculate the excess returns of portfolios by subtracting the risk-free rate from the value-weighted industry returns.

Table 9 presents the correlations between various portfolios and the innovation in the Biodiversity News Index. All the correlations are positive, with Spearman correlation coefficients ranging from 0.11 to 0.19. These magnitudes are similar to those observed for climate hedging portfolios when compared to aggregate climate news (Engle, Giglio, Kelly, Lee, and Stroebel, 2020; Alekseev, Giglio, Maingi, Selgrad, and Stroebel, 2022; Giglio, Kuchler, Stroebel, and Zeng, 2024). The positive correlation between portfolio returns and aggregate biodiversity risk shocks suggests that such portfolios are effective in hedging and distributing biodiversity risks. The highest correlation is observed in the portfolio sorted by the direct biodiversity disclosures, suggesting that firms making more explicit disclosures are more responsive to biodiversity risk with additional valuable information for investors. Overall, our findings imply that biodiversity risk disclosures provide meaningful insights into firms' risk exposures and risk profiles, enabling investors to better manage biodiversity-related risks. This aligns with Smith (2023)'s theoretical predictions regarding the value of environmental disclosures in risk management.

6 Conclusion

This study highlights the growing importance of biodiversity risk disclosure in corporate reporting and its significant implications for both investors and firms. While current disclosures remain voluntary, unaudited, and non-standardized, our findings indicate that they serve an essential function in responding to investor and stakeholder demands for greater transparency in biodiversity-related risks. The voluntary nature of these disclosures, combined with their coarse and often inconsistent formats, poses challenges for measuring and comparing biodiversity risk across firms. However, through our novel two-step method that integrates traditional natural language processing with advanced large language models, we were able to improve the accuracy and granularity of biodiversity risk assessments, offering deeper insights into the nature of these disclosures.

Our analysis of the determinants of biodiversity risk disclosure reveals that larger firms and those with higher institutional ownership are more likely to disclose these risks, reflecting the rising importance of biodiversity transparency among institutional investors. The competitive environment also plays a significant role, as firms are more likely to disclose biodiversity risks when their peers do so, indicating a growing trend of information sharing within industries. This peer influence, coupled with pressures from local communities and nonprofits, underscores the multifaceted drivers behind voluntary biodiversity risk reporting. Taken together, our findings suggest that firms that voluntarily disclose biodiversity risks appear to respond not only to investor demands but also to broader stakeholder pressures, including environmental activism and local community concerns.

Our results suggest that biodiversity risk disclosures, despite their limitations, provide tangible benefits for investors. These disclosures enable more informed evaluations of firms' exposure to biodiversity risks, influencing stock returns and enhancing risk management, particularly through portfolio hedging. Future research could further explore the long-term financial impact of biodiversity risk disclosures on firm performance and investor behavior, particularly as global awareness of biodiversity loss and its economic consequences continues to grow.

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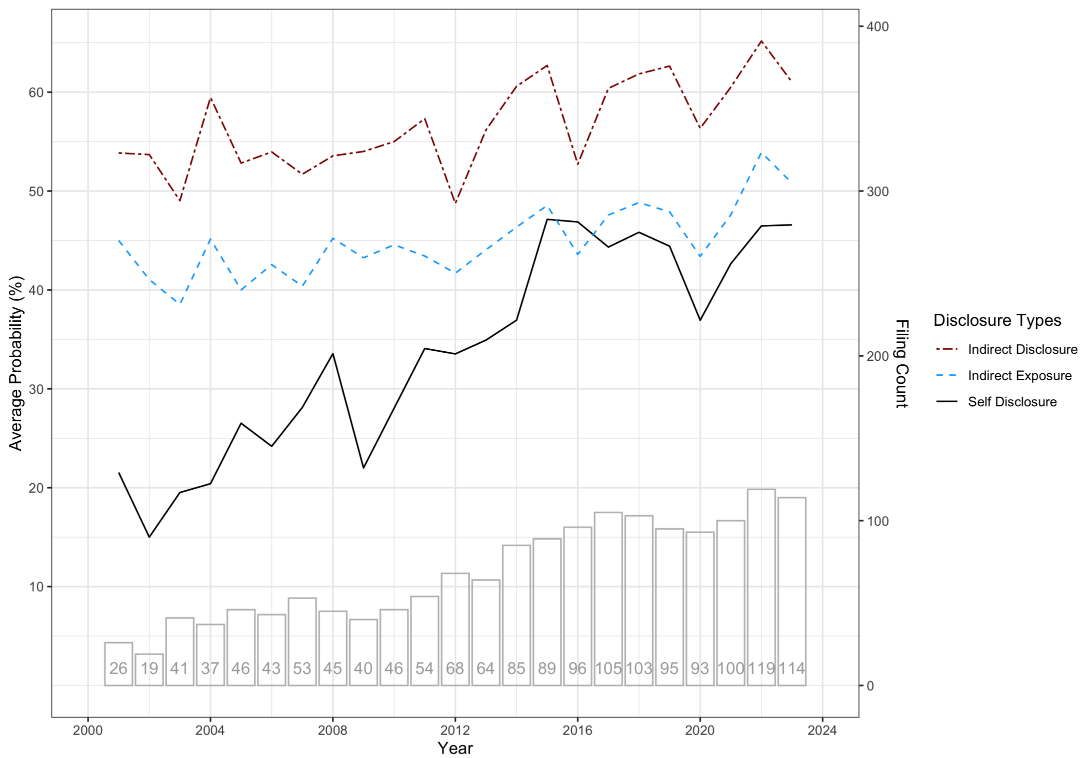
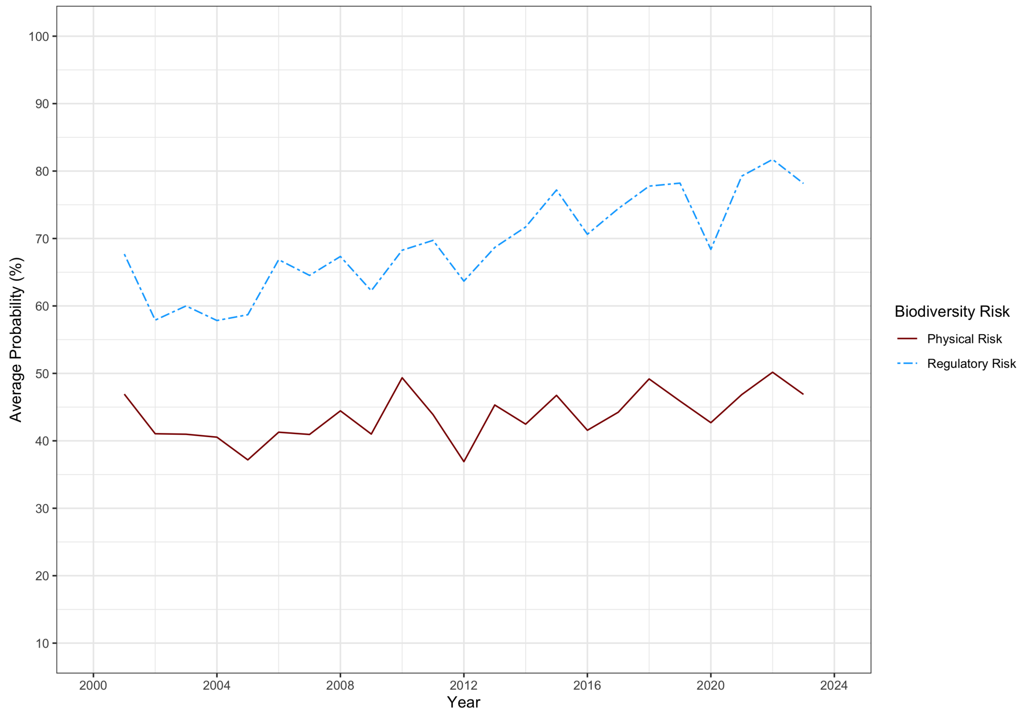
Figures

Figure 1: Disclosure Count and Types

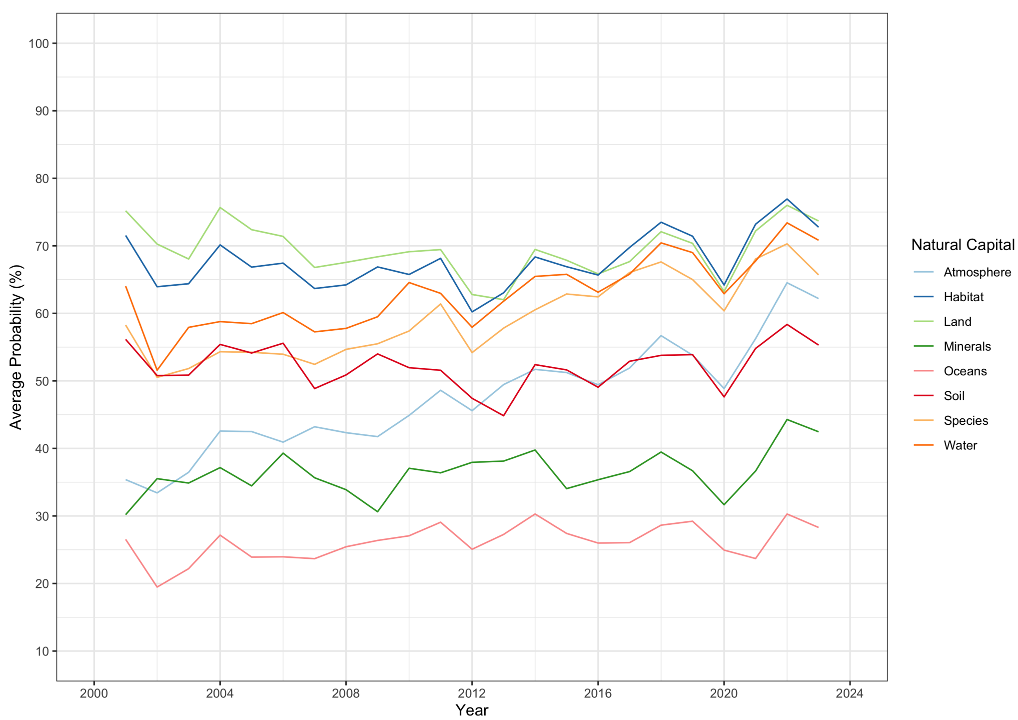


Note: Average probability of self disclosure in percentage (solid black line), average probability of indirect disclosure (dot-dashed red line), and average probability of indirect exposure (dashed blue line) from 2001 to 2023. The average probability percentages are computed as the simple average of probabilities of all disclosed firms in each year.

Figure 2: Biodiversity Risk Classification

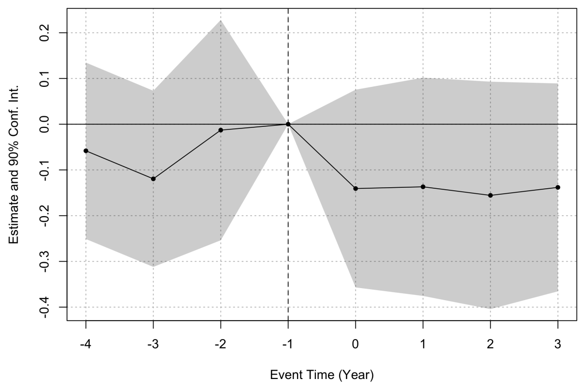


(a) Physical vs Regulatory Risk

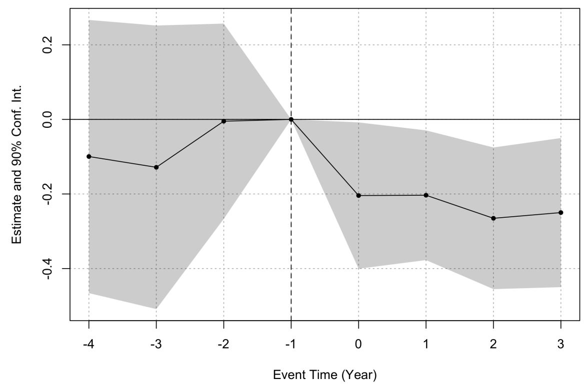


(b) Relevance to Natural Capital

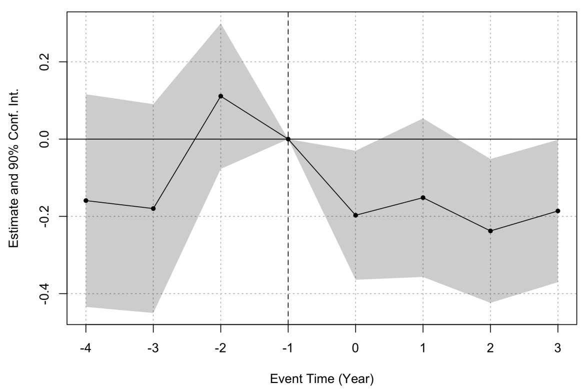
Figure 3: Impact of Voluntary Biodiversity Disclosure



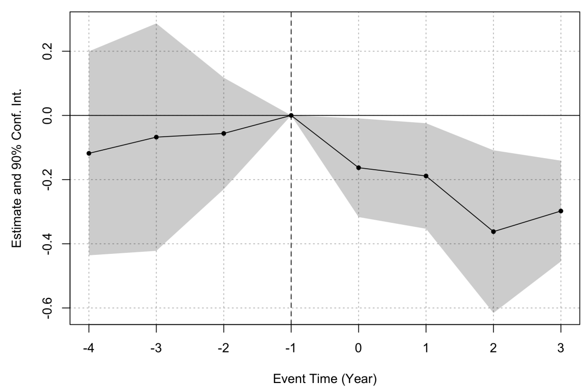
(a) Keyword Mentions



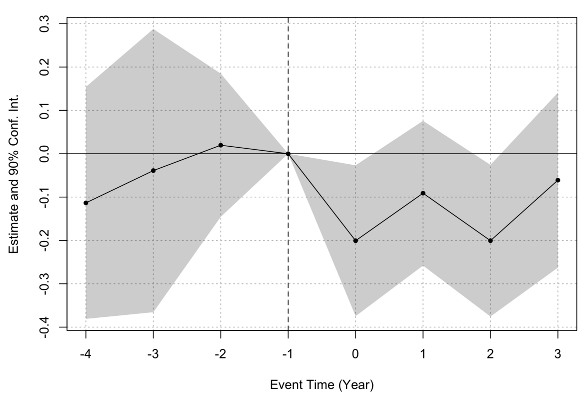
(b) ChatGPT Combined Disclosure



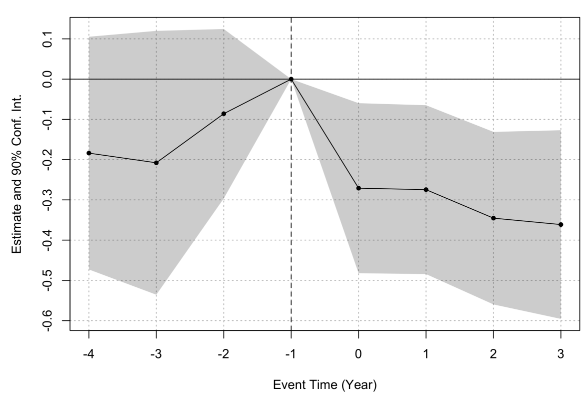
(c) Direct Disclosure



(d) Indirect Exposure



(e) Physical Risk Disclosure



(f) Regulatory Risk Disclosure

Note: Betas estimated using Fama and French 3 factors and weekly returns.

Tables

Table 1: Correlation between Biodiversity Disclosure Classifications

This table presents the Spearman correlation estimates between biodiversity disclosure classifications derived using ChatGPT on 10-K statements from 2010 to 2023. The data sample consists of US firms whose 10K filings contain at least two sentences with biodiversity-related keywords, as constructed in Giglio et al. (2024). *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations.

	Direct Disclosure	Indirect Disclosure	Indirect Exposure	Physical Risk
Indirect Disclosure	0.4956			
Indirect Exposure	0.2955	0.5421		
Physical Risk	0.3432	0.4731	0.3620	
Regulatory Risk	0.5765	0.5272	0.3382	0.4072

Table 2: Firm Characteristics and Biodiversity Disclosure

This table presents OLS regression estimates using data from 2001-2023. The sample includes firms whose 10K filings contain at least two sentences with biodiversity-related keywords, as constructed in Giglio et al. (2024), along with their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016). We define a cohort as a disclosing firm and its top 10 competitors that do not disclose. The dependent variable is a binary indicator of whether a firm's 10-K contains at least two sentences with biodiversity-related keywords. Firm characteristics are from Compustat, institutional ownership data from Thomson Reuters, and CEO managing characteristics from Boardex. *Institutional ownership* is the percentage of shares held by institutions. *CEO tenure* indicates if the CEO has been in the office for less than three years. Clustered (Cohort) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

						$\text{Disclose}_{i,t}$					
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\text{Size}_{i,t}$	0.0273^{***}										0.0101^{**}
	(0.0018)										(0.0048)
Log $\text{Revenue}_{i,t}$		0.0220^{***}									-0.0065
		(0.0021)									(0.0047)
Insti Ownership $\text{HHI}_{i,t}$ (%)			-0.0032^{***}								-0.0025^{***}
			(0.0002)								(0.0003)
Insti $\text{Ownership}_{i,t}$(%)				0.0944^{***}							0.0568^{***}
				(0.0250)							(0.0208)
CEO $\text{MBA}_{i,t}$					0.0292^{***}						0.0035
					(0.0081)						(0.0111)
CEO Legal $\text{Degree}_{i,t}$						0.0104					0.0041
						(0.0119)					(0.0147)
CEO $\text{Tenure}_{i,t}$							0.0164^{**}				0.0295^{***}
							(0.0077)				(0.0100)
Male $\text{Ratio}_{i,t}$(%)								-0.0032^{***}			-0.0023^{***}
								(0.0004)			(0.0005)
Board $\text{Nationality}_{i,t}$(%)									0.0023^{***}		0.0028^{***}
									(0.0003)		(0.0004)
Num $\text{Directors}_{i,t}$										0.0115^{***}	0.0005
										(0.0020)	(0.0028)
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,737	11,706	9,504	9,504	11,321	11,321	10,939	9,948	9,481	9,948	7,701
R^2	0.07958	0.07518	0.10604	0.10186	0.07153	0.07025	0.07234	0.08975	0.10265	0.08702	0.15559

Table 3: Firm Characteristics and Biodiversity Disclosure from Various Dimensions

This table presents OLS regression estimates using data from 2001-2023, with different biodiversity risk disclosures as the outcome variables. The dependent variable in column (0) is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). All other outcome variables are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016), with each cohort defined as a disclosing firm and its top 10 competitors that do not disclose. Firm characteristics are from Compustat, institutional ownership data from Thomson Reuters, and CEO managing characteristics from Boardex. *Institutional ownership* is the percentage of shares held by institutions, and *CEO tenure* indicates if the CEO has been in the office for less than three years. Clustered (Cohort) standard errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

Panel A. Model:	$\text{Disclose}_{i,t}$ (0)	I(Direct $\text{Disclosure})_{i,t}$ (1)	I(Indirect $\text{Disclosure})_{i,t}$ (2)	I(Indirect $\text{Exposure})_{i,t}$ (3)	I(Physical $\text{Risk})_{i,t}$ (4)	I(Regulatory $\text{Risk})_{i,t}$ (5)
$\text{Size}_{i,t}$	0.0101**	-0.0055	0.0009	-0.0025	0.0015	0.0010
	(0.0048)	(0.0042)	(0.0047)	(0.0045)	(0.0043)	(0.0049)
Log $\text{Revenue}_{i,t}$	-0.0065	0.0017	-0.0060	5.64×10^{-5}	0.0003	-0.0016
	(0.0047)	(0.0043)	(0.0046)	(0.0047)	(0.0043)	(0.0048)
Insti Ownership $\text{HHI}_{i,t}$ (%)	-0.0025***	-0.0007**	-0.0018***	-0.0015***	-0.0016***	-0.0018***
	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0004)
Insti $\text{Ownership}_{i,t}$(%)	0.0568***	0.0283**	0.0457**	0.0429***	0.0321**	0.0427**
	(0.0208)	(0.0112)	(0.0179)	(0.0148)	(0.0143)	(0.0174)
CEO $\text{MBA}_{i,t}$	0.0035	-0.0200**	-0.0164	-0.0004	-0.0020	-0.0100
	(0.0111)	(0.0081)	(0.0101)	(0.0096)	(0.0097)	(0.0101)
CEO Legal $\text{Degree}_{i,t}$	0.0041	-0.0170	-0.0282**	-0.0311**	-0.0224*	-0.0260*
	(0.0147)	(0.0104)	(0.0139)	(0.0123)	(0.0120)	(0.0143)
CEO $\text{Tenure}_{i,t}$	0.0295***	0.0293***	0.0539***	0.0411***	0.0358***	0.0466***
	(0.0100)	(0.0072)	(0.0095)	(0.0089)	(0.0085)	(0.0093)
Male $\text{Ratio}_{i,t}$(%)	-0.0023***	-0.0025***	-0.0016***	-0.0008	-0.0015***	-0.0020***
	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Board $\text{Nationality}_{i,t}$(%)	0.0028***	0.0008***	0.0019***	0.0014***	0.0018***	0.0018***
	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Num $\text{Directors}_{i,t}$	0.0005	-0.0003	-0.0003	0.0003	-0.0041*	-0.0008
	(0.0028)	(0.0019)	(0.0026)	(0.0023)	(0.0023)	(0.0025)
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,701	7,701	7,701	7,701	7,701	7,701
R^2	0.15559	0.32794	0.33359	0.32057	0.31548	0.35357
Within R^2	0.02936	0.01454	0.01937	0.01496	0.01663	0.01898

Table 3: Firm Characteristics and Biodiversity Disclosure from Various Dimensions (Cont.)

Panel B.								
	I(Land Risk)$_{i,t}$	I(Species Risk)$_{i,t}$	I(Oceans Risk)$_{i,t}$	I(Habitat Risk)$_{i,t}$	I(Water Risk)$_{i,t}$	I(Atmosphere Risk)$_{i,t}$	I(Soil Risk)$_{i,t}$	I(Minerals Risk)$_{i,t}$
Model:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Size$_{i,t}$	0.0002	-0.0009	-0.0003	0.0005	0.0025	0.0005	0.0050	0.0080**
	(0.0048)	(0.0049)	(0.0026)	(0.0048)	(0.0045)	(0.0043)	(0.0046)	(0.0032)
Log Revenue$_{i,t}$	-0.0012	-0.0012	-0.0044*	-0.0019	-0.0037	0.0012	-0.0011	-0.0046
	(0.0045)	(0.0047)	(0.0026)	(0.0045)	(0.0043)	(0.0042)	(0.0042)	(0.0030)
Insti Ownership HHI$_{i,t}$ (%)	-0.0021***	-0.0017***	-0.0008***	-0.0019***	-0.0019***	-0.0016***	-0.0018***	-0.0013***
	(0.0004)	(0.0003)	(0.0002)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)
Insti Ownership$_{i,t}$(%)	0.0411**	0.0456**	0.0132***	0.0437**	0.0414**	0.0373***	0.0321**	0.0154**
	(0.0173)	(0.0184)	(0.0049)	(0.0179)	(0.0168)	(0.0126)	(0.0144)	(0.0069)
CEO MBA$_{i,t}$	-0.0004	-0.0095	0.0025	-0.0028	-0.0091	-0.0073	-0.0010	0.0217***
	(0.0102)	(0.0099)	(0.0053)	(0.0103)	(0.0098)	(0.0089)	(0.0099)	(0.0067)
CEO Legal Degree$_{i,t}$	-0.0193	-0.0182	0.0217***	-0.0139	-0.0250*	-0.0105	-0.0245**	-0.0012
	(0.0131)	(0.0134)	(0.0071)	(0.0135)	(0.0133)	(0.0132)	(0.0119)	(0.0080)
CEO Tenure$_{i,t}$	0.0476***	0.0458***	0.0106**	0.0564***	0.0548***	0.0462***	0.0472***	0.0182***
	(0.0094)	(0.0089)	(0.0048)	(0.0095)	(0.0092)	(0.0084)	(0.0089)	(0.0059)
Male Ratio$_{i,t}$(%)	-0.0020***	-0.0021***	-0.0004*	-0.0019***	-0.0018***	-0.0025***	-0.0015***	-0.0010***
	(0.0005)	(0.0005)	(0.0003)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0003)
Board Nationality$_{i,t}$(%)	0.0016***	0.0017***	0.0007***	0.0019***	0.0014***	0.0014***	0.0015***	0.0001
	(0.0004)	(0.0004)	(0.0002)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0002)
Num Directors$_{i,t}$	-0.0009	-0.0013	-0.0009	-0.0016	0.0007	0.0022	-0.0042*	-0.0013
	(0.0025)	(0.0025)	(0.0013)	(0.0026)	(0.0025)	(0.0022)	(0.0024)	(0.0015)
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,701	7,701	7,701	7,701	7,701	7,701	7,701	7,701
R^2	0.34680	0.35101	0.30031	0.34799	0.37148	0.36219	0.36753	0.38492
Within R^2	0.01916	0.01930	0.00832	0.02024	0.01975	0.02340	0.01840	0.01421

Table 4: Prior Lawsuits and Biodiversity Disclosure

This table presents OLS regression estimates using data from 2001-2023, with different biodiversity risk disclosures as the outcome variables. The dependent variable in column (0) is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). All other outcome variables are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016), with each cohort defined as a disclosing firm and its top 10 competitors that do not disclose. The lawsuit data are from the Securities Class Action Clearinghouse (SCAC) filing database from Stanford Law School since the passage of the Private Securities Litigation Reform Act of 1995. We define biodiversity-related lawsuits as those with biodiversity-related keywords from the Biodiversity Dictionary and sustainability lawsuits as biodiversity and climate dictionaries from Giglio et al. (2024). Firm characteristics are from Compustat, institutional ownership data from Thomson Reuters, and CEO managing characteristics from Boardex. *Institutional ownership* is the percentage of shares held by institutions, and *CEO tenure* indicates if the CEO has been in the office for less than three years. Clustered (Cohort) standard errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

Model:	$\text{Disclose}_{i,t}$ (0)	I(Direct $\text{Disclosure})_{i,t}$ (1)	I(Indirect $\text{Disclosure})_{i,t}$ (2)	I(Indirect $\text{Exposure})_{i,t}$ (3)	I(Physical $\text{Risk})_{i,t}$ (4)	I(Regulatory $\text{Risk})_{i,t}$ (5)
Cumulative Biodiversity $\text{Lawsuits}_{i,t}$	0.0831	0.0614	0.0513	0.0522	0.0152	-0.0251
	(0.0583)	(0.0655)	(0.0771)	(0.0738)	(0.0659)	(0.0803)
Cumulative Sustainability $\text{Lawsuits}_{i,t}$	0.2403***	0.0813*	0.2233***	0.1547***	0.1766***	0.2171***
	(0.0629)	(0.0455)	(0.0544)	(0.0584)	(0.0542)	(0.0549)
$\text{Size}_{i,t}$	0.0104**	-0.0054	0.0012	-0.0023	0.0017	0.0011
	(0.0048)	(0.0042)	(0.0047)	(0.0045)	(0.0043)	(0.0049)
Log $\text{Revenue}_{i,t}$	-0.0069	0.0015	-0.0064	-0.0002	3.87×10^{-5}	-0.0018
	(0.0047)	(0.0043)	(0.0046)	(0.0047)	(0.0043)	(0.0048)
Insti Ownership $\text{HHI}_{i,t}$ (%)	-0.0025***	-0.0007**	-0.0018***	-0.0015***	-0.0016***	-0.0018***
	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0004)
Insti $\text{Ownership}_{i,t}$(%)	0.0562***	0.0281**	0.0451**	0.0425***	0.0316**	0.0421**
	(0.0207)	(0.0112)	(0.0177)	(0.0147)	(0.0142)	(0.0172)
CEO $\text{MBA}_{i,t}$	0.0031	-0.0201**	-0.0168*	-0.0007	-0.0023	-0.0105
	(0.0111)	(0.0081)	(0.0101)	(0.0095)	(0.0097)	(0.0101)
CEO Legal $\text{Degree}_{i,t}$	0.0031	-0.0175*	-0.0289**	-0.0317***	-0.0227*	-0.0261*
	(0.0146)	(0.0104)	(0.0138)	(0.0122)	(0.0119)	(0.0141)
CEO $\text{Tenure}_{i,t}$	0.0292***	0.0294***	0.0534***	0.0409***	0.0353***	0.0458***
	(0.0100)	(0.0072)	(0.0095)	(0.0089)	(0.0085)	(0.0093)
Male $\text{Ratio}_{i,t}$(%)	-0.0023***	-0.0025***	-0.0016***	-0.0008	-0.0015***	-0.0020***
	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Board $\text{Nationality}_{i,t}$(%)	0.0028***	0.0008***	0.0019***	0.0014***	0.0018***	0.0018***
	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Num $\text{Directors}_{i,t}$	0.0004	-0.0003	-0.0003	0.0003	-0.0042*	-0.0010
	(0.0028)	(0.0019)	(0.0025)	(0.0023)	(0.0023)	(0.0025)
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,701	7,701	7,701	7,701	7,701	7,701
R^2	0.15908	0.32866	0.33617	0.32213	0.31742	0.35591
Within R^2	0.03337	0.01559	0.02318	0.01723	0.01942	0.02253

Table 5: Peer Pressure and Biodiversity Disclosure

This table presents OLS regression estimates using data from 2001-2023, with different biodiversity risk disclosures as the outcome variables. The dependent variable in column (1) is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). All other outcome variables are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016). *# of Disclosed Competitors* is defined the number of top direct competitors that disclose for each firm in the sample each year. We also control for firm characteristics, institutional ownership, CEO characteristics and managing style. Clustered (Firm, year) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

Model:	Keyword Mention$_{i,t}$ (1)	I(Direct Disclosure)$_{i,t}$ (2)	I(Indirect Disclosure)$_{i,t}$ (3)	I(Indirect Exposure)$_{i,t}$ (4)	I(Physical Risk)$_{i,t}$ (5)	I(Regulatory Risk)$_{i,t}$ (6)
# of Disclosed Competitors	0.0116	0.0159**	0.0191***	0.0109*	0.0088	0.0146**
	(0.0080)	(0.0063)	(0.0067)	(0.0061)	(0.0088)	(0.0068)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm, Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,726	4,726	4,726	4,726	4,726	4,726
R^2	0.68091	0.53226	0.63439	0.52643	0.56807	0.64617
Within R^2	0.00680	0.00775	0.00697	0.00453	0.00690	0.00513

Table 6: Biodiversity and Environmental Protests

This table presents OLS regression estimates using data from 2001-2023, with different biodiversity risk disclosures as the outcome variables. The dependent variable in column (1) is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). All other outcome variables are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016), with each cohort defined as a disclosing firm and its top 10 competitors that do not disclose. The protest data are from the Crowd Counting Consortium (CCC) by Harvard Kennedy School and the University of Connecticut. We used biodiversity keywords and climate keywords to identify biodiversity and environment-related protests. The county-level measures are aggregated to the firm level using the establishment data from Your-economy Time Series (YTS), weighted by the number of employees. We also control for firm characteristics, institutional ownership, CEO characteristics and managing style. Clustered (Cohort) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

	$\text{Disclose}_{i,t}$		$\text{I(Direct Disclosure)}_{i,t}$		$\text{I(Indirect Disclosure)}_{i,t}$		$\text{I(Indirect Exposure)}_{i,t}$	
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Environment Protests}_{i,t}$	-0.0046*		-0.0003		-0.0033		-0.0041*	
	(0.0025)		(0.0018)		(0.0023)		(0.0021)	
$\text{Biodiversity Protests}_{i,t}$		0.4214		0.0339		0.4924*		0.5913**
		(0.2977)		(0.1225)		(0.2780)		(0.2756)
$\text{Size}_{i,t}$	-0.0144	-0.0135	0.0041	0.0042	-0.0073	-0.0066	-0.0166	-0.0158
	(0.0176)	(0.0176)	(0.0122)	(0.0122)	(0.0158)	(0.0158)	(0.0151)	(0.0151)
Log $\text{Revenue}_{i,t}$	0.0086	0.0087	-0.0051	-0.0051	0.0043	0.0047	0.0100	0.0105
	(0.0176)	(0.0177)	(0.0109)	(0.0109)	(0.0158)	(0.0159)	(0.0155)	(0.0156)
Insti Ownership $\text{HHI}_{i,t}$ (%)	-0.0019*	-0.0021**	-0.0009	-0.0010	-0.0016*	-0.0019*	-0.0016*	-0.0018**
	(0.0010)	(0.0010)	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0009)	(0.0008)
Insti $\text{Ownership}_{i,t}$(%)	0.0624	0.0615	0.0337	0.0336	0.0567	0.0554	0.0409	0.0394
	(0.0448)	(0.0434)	(0.0231)	(0.0230)	(0.0412)	(0.0396)	(0.0317)	(0.0298)
CEO $\text{MBA}_{i,t}$	-0.0653**	-0.0613*	-0.0508**	-0.0505**	-0.0670**	-0.0625**	-0.0225	-0.0170
	(0.0325)	(0.0327)	(0.0238)	(0.0240)	(0.0304)	(0.0306)	(0.0300)	(0.0301)
CEO Legal $\text{Degree}_{i,t}$	-0.0103	-0.0117	-0.0208	-0.0209	-0.0233	-0.0254	-0.0213	-0.0238
	(0.0480)	(0.0484)	(0.0311)	(0.0311)	(0.0464)	(0.0467)	(0.0396)	(0.0399)
CEO $\text{Tenure}_{i,t}$	0.0143	0.0176	0.0187	0.0190	0.0117	0.0153	0.0166	0.0209
	(0.0303)	(0.0308)	(0.0216)	(0.0218)	(0.0281)	(0.0284)	(0.0269)	(0.0274)
Male $\text{Ratio}_{i,t}$(%)	-0.0060***	-0.0059***	-0.0035***	-0.0035***	-0.0056***	-0.0055***	-0.0054***	-0.0053***
	(0.0016)	(0.0016)	(0.0012)	(0.0012)	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Board $\text{Nationality}_{i,t}$(%)	0.0024**	0.0024**	0.0013	0.0012	0.0022**	0.0022**	0.0011	0.0011
	(0.0011)	(0.0011)	(0.0008)	(0.0008)	(0.0010)	(0.0010)	(0.0010)	(0.0009)
Num $\text{Directors}_{i,t}$	-0.0081	-0.0095	-0.0057	-0.0058	-0.0079	-0.0092	-0.0064	-0.0080
	(0.0088)	(0.0088)	(0.0053)	(0.0053)	(0.0084)	(0.0084)	(0.0069)	(0.0069)
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	959	959	959	959	959	959	959	959
R^2	0.17151	0.17217	0.28152	0.28153	0.18641	0.18859	0.19323	0.19684

Table 7: Local Google Search and Biodiversity Disclosure

This table presents OLS regression estimates using data from 2001-2023, with different biodiversity risk disclosures as the outcome variables. The dependent variable in column (1) is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). All other outcome variables are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016). We obtained the metropolitan-area-level Google trend index on the topic of "biodiversity" using Google Trends API. We aggregate Google search index to the firm level using the establishment data from Your-economy Time Series (YTS), weighted by the number of employees. We also control for firm characteristics, institutional ownership, CEO characteristics and managing style. Clustered (firm, year) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

Model:	$\text{Disclose}_{i,t}$ (1)	I(Self $\text{Disclosure})_{i,t}$ (2)	I(Indirect $\text{Disclosure})_{i,t}$ (3)	I(Indirect $\text{Exposure})_{i,t}$ (4)	I(Physical $\text{Risk})_{i,t}$ (5)	I(Regulatory $\text{Risk})_{i,t}$ (6)
Biodiversity Search $\text{Index}_{i,t}$	0.0024	0.0014	0.0036*	0.0046**	0.0025	0.0035**
	(0.0017)	(0.0013)	(0.0019)	(0.0018)	(0.0019)	(0.0016)
Firm, Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,890	2,890	2,890	2,890	2,890	2,890
R^2	0.71582	0.58078	0.69877	0.57149	0.65091	0.70437

Table 8: Hedging Performance of Biodiversity Risk Exposure

This table presents OLS regression estimates using data from 2001-2023. The dependent variable is the excess return of each firm in each year month. *KeywordMentions* is a binary indicator of whether a firm's 10-K contains at least two biodiversity-related sentences, as identified by Giglio et al. (2024). The other disclosure types are classified by ChatGPT, where a firm is considered to disclose or be exposed to a risk if the ChatGPT-provided probability is 0.5 or higher. *Direct disclosure* refers to the explicit acknowledgment of biodiversity risks, while *Indirect disclosure* implies business-related risks without explicitly labeling them as biodiversity risks. *Indirect exposure* captures upstream or downstream risks, such as those related to supply chains, partners, or customers. *Physical risk* refers to business impacts from biodiversity degradation and *regulatory risk* is related to effects resulting from stricter biodiversity regulations. *BioNewsInnovation* is the residuals from AR(1) model using New York Times Biodiversity News Index constructed in Giglio et al. (2024). The sample includes disclosing firms and their top 10 closest competitors from the Hoberg-Phillips product market competitor database (Hoberg and Phillips, 2010, 2016). We also control for firm characteristics including size and revenue, and institutional ownership. Clustered (firm, year-month, and year-industry) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

	Excess Return$_{i,t}$						
Model:	(0)	(1)	(2)	(3)	(4)	(5)	(6)
Keyword Mentions$_{i,t-1}$	-0.5492***						
	(0.1872)						
Keyword Mentions$_{i,t-1}$ × BioNewsInnovation$_{t-1}$	-0.0777**						
	(0.0343)						
ChatGPT Disclose$_{i,t-1}$		-0.4245*					
		(0.2172)					
ChatGPT Disclose$_{i,t-1}$ × BioNewsInnovation$_{t-1}$		-0.0915*					
		(0.0500)					
I(Direct Disclosure)$_{i,t-1}$			-0.3823*				
			(0.2302)				
I(Direct Disclosure)$_{i,t-1}$ × BioNewsInnovation$_{t-1}$			-0.0738				
			(0.0529)				
I(Indirect Disclosure)$_{i,t-1}$				-0.3702*			
				(0.2085)			
I(Indirect Disclosure)$_{i,t-1}$ × BioNewsInnovation$_{t-1}$				-0.0723			
				(0.0495)			
I(Indirect Exposure)$_{i,t-1}$					-0.3242		
					(0.2319)		
I(Indirect Exposure)$_{i,t-1}$ × BioNewsInnovation$_{t-1}$					-0.0627**		
					(0.0262)		
I(Physical Risk)$_{i,t-1}$						-0.4661**	
						(0.2272)	
I(Physical Risk)$_{i,t-1}$ × BioNewsInnovation$_{t-1}$						-0.0903***	
						(0.0337)	
I(Regulatory Risk)$_{i,t-1}$							-0.3756*
							(0.2178)
I(Regulatory Risk)$_{i,t-1}$ × BioNewsInnovation$_{t-1}$							-0.1141**
							(0.0506)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm, Year-month, Year-Industry FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,215	23,215	23,215	23,215	23,215	23,215	23,215
R^2	0.28272	0.28270	0.28257	0.28258	0.28253	0.28275	0.28283

Table 9: Biodiversity Hedge Performance of Various Portfolios

This table presents the correlation between biodiversity measures from 10K filing and innovations in biodiversity news from NYT, using data from 2010 to 2020. Innovations in biodiversity news are the residuals from the AR(1) model using the New York Times Biodiversity News Index constructed in Giglio et al. (2024). The hedging portfolios are based on various risk exposure measures, including keyword mentions, direct disclosure, indirect disclosure, indirect exposure, physical risk, and regulatory risk. Each portfolio is constructed by aggregating firm-level exposures to the industry level, weighted by the firm's market capitalization. In each portfolio, we take long positions in firms with low biodiversity risk exposure and short positions in firms with high biodiversity risk exposure. The portfolio weights are based on each industry's biodiversity risk exposure percentile within the overall industry distribution.

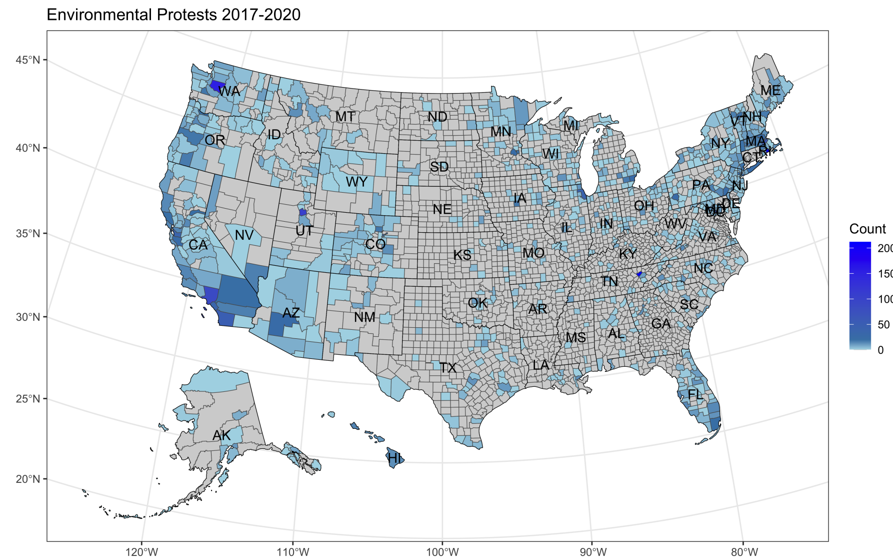
Variable	Spearman	Kendall	Pearson
10K Count	0.1164	0.0772	0.1150
Direct Disclosure	0.1903	0.1292	0.1448
Indirect Disclosure	0.1316	0.0846	0.1193
Indirect Exposure	0.1400	0.0894	0.1236
Physical Risk	0.1098	0.0732	0.0972
Regulatory Risk	0.1350	0.0855	0.1152

Appendix

Figure A1: Word cloud of the 10K paragraphs with biodiversity-related keywords

Note: this is based on the 400 words before and after each biodiversity-related keyword in 10K statements

Figure A2: Environmental Protests



Note: Data source: Crowd Counting Consortium (CCC)

Figure A3: Google Trends on Biodiversity in 2010

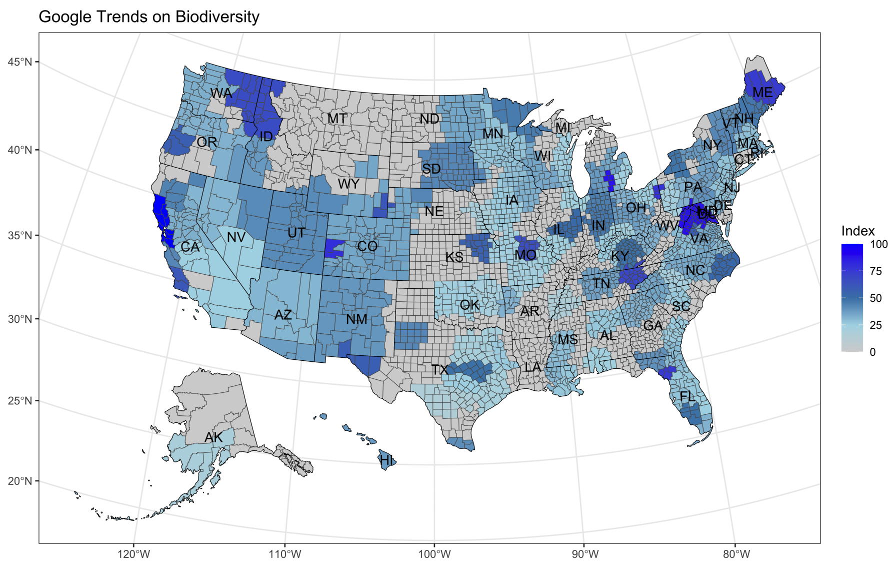


Figure A4: Google Trends on Biodiversity in 2023

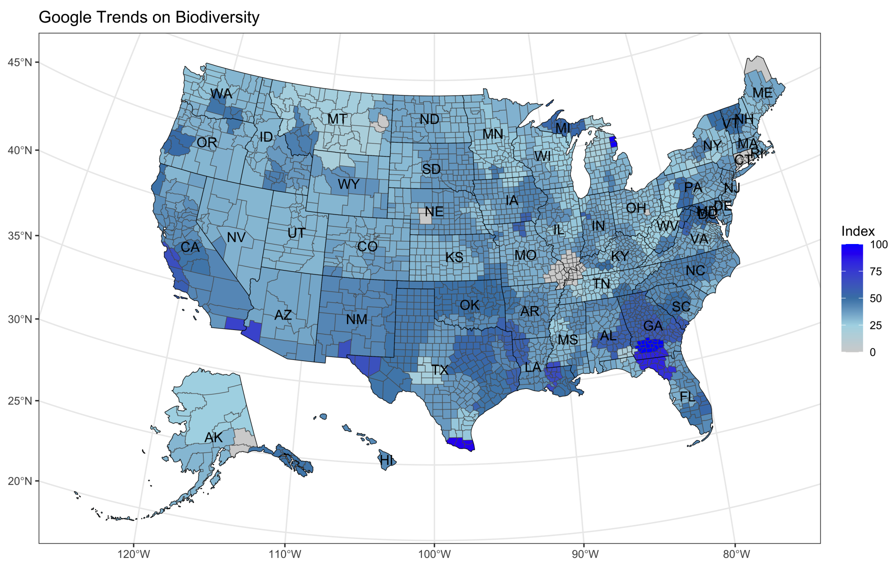


Table A1: 10-K Disclosure Classification Examples: Direct Disclosure

Statement	ChatGPT Explanation:
PEABODY ENERGY (2022) The ESA (Endangered Species Act) of 1973 and counterpart state legislation is intended to protect **species** whose populations allow for categorization as either endangered or threatened. Changes in listings or requirements under these regulations could have a material adverse effect on Peabody's costs or its ability to mine some of its properties in accordance with its current mining plans.	The disclosure explicitly mentions the Endangered Species Act (ESA) and outlines how changes in listings or requirements under these regulations could have a material adverse effect on Peabody's costs or its ability to mine some of its properties. This direct acknowledgment of species protection and its potential impact on operations indicates a high likelihood of self-disclosed biodiversity risk.
PORTLAND GENERAL ELECTRIC (2006) Restoration of Salmon Runs Populations of many salmon species in the Pacific Northwest have shown significant decline over the last several decades. Several of these species have been granted protection under the federal Endangered Species Act (ESA). Long-term recovery plans for these species include major operational changes to the region's hydroelectric projects.	The company explicitly acknowledges the risk associated with the decline in salmon populations due to its hydroelectric operations. The text mentions that several salmon species protected under the federal Endangered Species Act (ESA) have experienced significant declines, leading to major operational changes to hydroelectric projects. These changes have resulted in a loss of energy generation capacity and a seasonal shift in hydroelectric generation, which are directly linked to business outcomes.
CONCHO RESOURCES (2017) The federal **Endangered Species Act** (the ESA) and analogous state laws regulate activities that could have an adverse effect on threatened or endangered **species**. Some of our drilling operations are conducted in areas where protected **species** are known to exist. In these areas, we may be obligated to develop and implement plans to avoid potential adverse impacts to protected **species**, and we may be prohibited from conducting drilling operations in certain locations or during certain seasons.	The excerpt explicitly mentions the impact on endangered species due to drilling operations ('The presence of a protected species in areas where we perform drilling activities could impair our ability to...'). This directly links biodiversity risks to operational outcomes and thus qualifies as a self-disclosed risk.

Table A2: 10-K Disclosure Classification Examples: Indirect Disclosure

Statement	ChatGPT Explanation:
United Parks & Resorts (2013) With approximately 12,000 animals representing more than 250 **species**, Busch Gardens Tampa offers more owned land, including through acquisitions. With approximately 12,000 animals representing more than 250 **species**, Busch Gardens Tampa offers more opportunities to learn about and interact with amazing animals than any other of our theme parks. ...corporate member of the SeaWorld Busch Gardens Conservation Fund, a non-profit conservation foundation, which makes grants to **wildlife** research and conservation projects that protect **wildlife** and wild places worldwide.	The firm highlights its commitment to protecting and preserving the environment and the natural world, which could be seen as an indirect acknowledgement of biodiversity. However, this information is presented more as part of its corporate identity and philanthropic efforts rather than explicitly labeling biodiversity risk as a direct threat to its business operations. The company relies heavily on its extensive collection of marine and terrestrial animals for its theme park operations, which implies a strong dependency on biodiversity. Any decline in animal populations or adverse impacts on natural ecosystems could severely affect their ability to maintain their attractions and the guest experiences they offer. This indirect exposure to biodiversity risk is crucial for the business's sustainability and should be considered a significant risk.
ALLETE (2011) A substantial portion of our development properties in Florida are subject to federal, state and local regulations, and restrictions that may impose significant costs or limitations on our ability to develop the properties. Much of our property is vacant land and some is located in areas where development may affect the natural **habitats** of various protected **wildlife species** or in sensitive environmental areas such as **wetlands**.	The excerpt does not provide any direct acknowledgment of biodiversity risks. There is no explicit link made between biodiversity risks and the company's business outcomes in the financial statement. Thus, the likelihood of this being a self-disclosed biodiversity risk is low. The disclosure indirectly indicates potential exposure to biodiversity risks through various dependencies on natural resources. For instance, BNI Coal's reclamation obligations and real estate activities in environmentally sensitive areas (wetlands and habitats of protected species) suggest impacts on biodiversity.

Table A2: 10-K Disclosure Classification Examples: Indirect Disclosure (Cont.)

Statement	ChatGPT Explanation:
LGI Homes (2020) We are subject to a variety of local, state, federal and other laws, statutes, ordinances, rules and regulations concerning the environment, hazardous materials, the discharge of pollutants and human health and safety. ... in those cases where an endangered or threatened **species** is involved, environmental rules and regulations can result in the restriction or elimination of development in identified environmentally sensitive areas.	The disclosed information does not contain any explicit acknowledgment of biodiversity risks. The discussion of environmental regulations is broad and does not directly link biodiversity risks to the company's business outcomes. The excerpt discusses the impact of environmental regulations on the company's operations, including restrictions related to endangered species and sensitive habitats. Although biodiversity risks are not explicitly mentioned, it can be inferred that the firm's operations could be impacted by biodiversity loss through environmental laws aimed at protecting such species and habitats.

Table A3: 10-K Disclosure Classification Examples: Indirect Exposure

Statement	ChatGPT Explanation:
ENNIS (2021) Our primary supplier is SFI, FSC and PEFC certified. The SFI **Forest** Management Standard covers key values such as protection of **biodiversity**, species at risk and **wildlife habitat** sustainable harvest levels protection of water quality and prompt regeneration. FSC certification ensures that products come from responsibly-managed forests that provide environmental, social and economic benefits. PEFC cares for forests globally and locally. They work to protect our forests by promoting sustainable forest management through certification. This means that all can benefit from the many products that forests provide now, while ensuring these forests will be around for generations to come. The Company's primary paper supplier insures that all of their supply chain materials are sourced with similar accredited suppliers allowing for more transparency and a more trustworthy supplier commitment to quality, safety and the protection of our natural resources.	The company mentions its primary paper supplier's commitment to biodiversity through certifications such as SFI, FSC, and PEFC. This implies an indirect exposure to biodiversity risks through their supply chain, given that disruptions in the supplier's ability to maintain biodiversity standards could impact the company's raw material supply. The focus on suppliers' sustainable practices indicates a reliance on ecosystem health, though not directly framed as a risk. While the environmental initiatives and conservation efforts are mentioned, the disclosure does not connect these practices to the company's business outcomes in a way that clearly implies a risk. The focus is more on sustainable practices and compliance rather than identifying specific biodiversity-related risks.
Moderna (2019) Our vaccine research approach starts by identifying the antigens most likely to induce a protective immune response against a specific infectious disease. We test one or more antigens in vivo in multiple animal **species**. . . . Influenza A viruses infect a variety of **species**, including birds, pigs, sea mammals, and humans. Wild **aquatic** birds serve as the reservoir of influenza A viruses infecting avian and mammalian **species**. Although many of these viruses are non-pathogenic in birds and most do not infect humans, in recent decades, some avian influenza viruses such as H10N8 and H7N9 have crossed the **species** barrier to cause human disease.	There is a potential for indirect exposure to biodiversity risks related to the sourcing and testing of biological materials (e.g., antigens, proteins) which might impact the supply chain or regulatory environment. However, this is not clearly stated and would require further detailed information about their supply chain dependencies on biodiversity. Stakeholders such as suppliers (e.g., for biological specimens or raw materials) could face biodiversity-related regulations or challenges that might indirectly affect the company.

Table A3: 10-K Disclosure Classification Examples: Indirect Exposure (Cont.)

Statement	ChatGPT Explanation:
MERCER INTERNATIONAL (2013) During the past few years, certain customers have endeavored to purchase pulp that is produced using fiber that meets certain recognized wood certification requirements from **forest** certification agencies like FSC, PEFC, SFI-CSA. . . . Offsetting some of the increases in demand for wood fiber have been initiatives in which we and other producers are participating to increase harvest levels in Germany, particularly from small private **forest** owners.	The company's reliance on a supply chain dependent on sustainable forestry practices and the certification of wood sources suggests indirect exposure to biodi- versity risks through suppliers. The focus on ensuring that wood certification standards are met implies a connection to maintaining biodiversity standards up- stream. The competition for wood residuals driven by green energy initiatives can also indirectly impact biodiversity, adding further to the risk.