Are Banks Concerned about Borrowers' Biodiversity Risk?*

Mengdie Deng
dengmd7@mail.sysu.edu.cn
Lingnan College
Sun Yat-sen University

Tse-Chun Lin
tsechunlin@hku.hk
HKU Business School
The University of Hong Kong

July 2025

Abstract

We find a positive correlation between borrowing firms' biodiversity risk and their loan spreads. For mechanisms, we find that banks respond differently to borrowers with regulatory risk ("Perpetrators") and physical risk ("Victims"). Specifically, banks that are often criticized for funding biodiversity-harming sectors ("Sin Banks") impose higher spreads on Perpetrators due to their proficiency in handling such loans but charge lower spreads for Victims owing to government support. Relationship lending alleviates the negative impact of physical risk on loan costs, but not regulatory risk. We leverage biodiversity litigation as an exogenous shock to firms' biodiversity risk and obtain consistent results.

JEL Classification: C45, G32, Q54

Keywords: Biodiversity risk, syndicated loan spreads, regulatory risk, physical risk, biodiversity litigation, sustainable finance

---

* We sincerely thank Guojun He, Roni Michaely, Sami Vähämaa, Zacharias Sautner, Zoey Yiyuan Zhou, and conference participants of the 2023 HKU Inaugural ESG Conference, 2025 Lapland Financial Institutions Summit, and seminar participants at Zhejiang University. All errors are ours.

Are Banks Concerned about Borrowers' Biodiversity Risk?

July 2025

Abstract

We find a positive correlation between borrowing firms' biodiversity risk and their loan spreads. For mechanisms, we find that banks respond differently to borrowers with regulatory risk ("Perpetrators") and physical risk ("Victims"). Specifically, banks that are often criticized for funding biodiversity-harming sectors ("Sin Banks") impose higher spreads on Perpetrators due to their proficiency in handling such loans but charge lower spreads for Victims owing to government support. Relationship lending alleviates the negative impact of physical risk on loan costs, but not regulatory risk. We leverage biodiversity litigation as an exogenous shock to firms' biodiversity risk and obtain consistent results.

JEL Classification: C45, G32, Q54

Keywords: Biodiversity risk, syndicated loan spreads, regulatory risk, physical risk, biodiversity litigation, sustainable finance

Protesters in front of Citibank's Manhattan headquarters were wearing robes and holding signs reading "biodiversity loss," "bleached corals," and "heat waves."

——WNCT Greenville, July 9, 2024

1. Introduction

The silent crisis of biodiversity loss demands urgent attention, exemplified by the alarming decline of bee populations: commercial beekeepers reported over 50% losses this winter, costing $139 million (Forbes, 2025). This incident is not merely an agricultural issue but a systemic economic threat, jeopardizing crop pollination, food security, and ecosystem services critical to human well-being. Biodiversity loss intertwines ecological collapse with economic and social risks, including species extinction, habitat destruction, and diminished agricultural productivity, which exacerbates vulnerability to pests, diseases, and resource scarcity (e.g., Heal, 2004; Dasgupta, 2021; Raynor et al., 2021; WEF, 2023; Frank and Sudarshan, 2024). The World Economic Forum's 2023 Global Risks Report ranks biodiversity loss as a top long-term global threat, underscoring its capacity to destabilize economies and societies.

While this novel risk has gained increasing public and policy attention, academic research on the financial implications remains underdeveloped. Although banks now recognize that ecosystem degradation affects their clients' financial health and default risks, rigorous analysis of how biodiversity concerns shape lending practices is still scarce. Our study addresses this gap by examining whether banks factor borrowers' biodiversity risk into their credit decisions and exploring the conditions that heighten or mitigate such considerations.

We propose that banks charge higher interest rates for borrowers with biodiversity risks. To clarify our framework, we categorize borrowing firms into two groups: "Perpetrators" and "Victims". Similar to the prior research on how climate change risks affect bank lending decisions (e.g., Battiston et al., 2021; Ivanov et al., 2024), the "Perpetrators" face regulatory (transition) risks arising from regulations and policies aimed at preventing biodiversity loss. The "Victims" encompass firms that experience adverse effects on their business operations and profitability due to the physical risks associated with biodiversity decline (Huang et al., 2022). These risks and costs might deteriorate firms' financial health and ability to repay the loans. Hence, risk-averse banks should charge higher interest rates to their borrowing firms with significant biodiversity exposures.

However, banks' responses to biodiversity risks can be more nuanced. On the one hand, banks might offer lower interest rates to firms that actively address biodiversity concerns. In particular, among firms facing elevated biodiversity risks, those that have demonstrated awareness and are taking proactive measures may receive favorable loan terms. This special treatment could signal banks' green preferences and sustainability commitment through pricing strategies (Dai et al., 2021; Pástor et al., 2021, 2022). On the other hand, banks might disregard biodiversity risks if they perceive limited financial materiality for borrowers. In this case, biodiversity considerations would play a minimal role in lending decisions. The relation between borrowers' biodiversity risk and their loan spreads thus remains an empirical question.

To test these competing hypotheses, we use syndicated loan data from the DealScan database and firm-level biodiversity risk metrics as outlined in Giglio et al. (2023).[1] Our analysis encompasses a period spanning from 2004 to 2019. The results show a positive correlation between biodiversity risk levels and loan spreads. Specifically, we observe an economic impact ranging from a 30.3 to a 51.3 basis-point increase in loan spreads for borrowers who disclose biodiversity risks in their 10-K reports, as opposed to those who do not. Our findings are robust to controlling for various other climate risks, as identified in

[1] Biodiversity-risk data are still nascent. We rely on firm-level disclosures in 10-K filings, which capture financially material biodiversity risks that banks should have long noticed (Heal, 2004; Giglio et al., 2023). In contrast, Iceberg DataLab relies on estimation risk based on the input–output method (Garel et al., 2024), and the S&P Nature & Biodiversity Risk dataset begins only in 2021, yielding a very short sample period (Canipek et al., 2024; Degl'Innocenti et al., 2025). Details are discussed in Section 3.1.

Sautner et al. (2023) and environmental risks derived from the RepRisk database. The results hold using alternative spread measures that account for net upfront fees and an alternative firm-year level sample structure. Additionally, we also show that firms' biodiversity risk is positively associated with their interest expense, corroborating the evidence from loan spreads.

To explore banks' unique role in biodiversity financing, we analyze how their lending patterns differ between Perpetrators (firms facing high regulatory risks) and Victims (firms facing high physical risks). Our findings reveal that both regulatory and physical biodiversity risks can lead to higher loan spreads. However, banks being criticized for financing sectors that drive biodiversity loss, referred to as "Sin Banks," tend to charge higher spreads on loans to Perpetrators. We attribute the finding to Sin Banks' experience in managing such "sin loans" and their proficiency in incorporating regulatory risks into lending decisions. In contrast, these Sin Banks show less concern for Victims and charge lower spreads than other banks, partly because of better knowledge that governments will support such borrowing firms through tax deductions.

Furthermore, we find that relationship lending only reduces loan spreads for Victims. Specifically, relationship lending mitigates the positive link between biodiversity risk and loan spreads when the risk is physical. We find no such mitigating effect when the biodiversity risk comes from a regulatory source. This result indicates that banks are adept at distinguishing between Perpetrators and Victims during repeated lending interactions.

Next, we employ state-level biodiversity lawsuits as an exogenous shock to provide a plausible causal inference between biodiversity risk and bank loan pricing. We propose that these legal actions create sudden, external pressure on companies headquartered in affected states, heightening their awareness of biodiversity risks. In response, firms implement risk mitigation strategies to prevent future risk realization. After companies demonstrate these risk-reduction efforts, the perceived biodiversity risks from these borrowers are reduced. Banks thus adjust loan pricing downward. This mechanism aligns with previous research showing how exogenous litigation increases managers' perceived risks and thus reduces companies' risk policy accordingly (Levy et al., 2018; Huang et al., 2020; Chen et al., 2021).[2] The initiation of state-level lawsuits can thus be considered relatively exogenous to firm-specific decisions regarding biodiversity risk management and the subsequent bank loan outcomes of certain borrowers. Consistently, we find that these biodiversity lawsuits are associated with reduced bank loan spreads.

Our study contributes to several lines of literature. First, it addresses the call for biodiversity finance research by Karolyi and Tobin-de la Puente (2023), who emphasize the need to understand how biodiversity risks are priced and how private capital can be effectively intermediated. While financial institutions have historically paid less attention to biodiversity risk compared to other environmental concerns, growing recognition of biodiversity loss as a systemic financial threat positions biodiversity conservation as a critical focus for sustainable finance. Our findings contribute to this emerging literature by providing evidence on how financial institutions price biodiversity risk (Cherief et al., 2022; Coqueret and Giroux, 2023; Garel et al., 2024).

Second, our study adds to research on banks' influences on ESG issues. Banks can encourage superior risk management practices among borrowers through their lending decisions (Barigozzi and Tedeschi, 2015). Recent studies show lenders not only select borrowers based on ESG alignment but also actively influence their ESG performance (Houston and Shan, 2022). By examining banks' consideration of biodiversity issues, we document their nuanced roles in addressing firms' regulatory and physical biodiversity risks.

[2] The Supreme Court ruling in *Gantler v. Stephens* (2009) increased non-board serving CFO's perceived litigation risk, leading them to adopt more conservative policies (Levy et al., 2018). Conversely, the Ninth Circuit ruling in Silicon Graphics Inc. Securities Litigation reduced managers' perceived litigation risk, enabling managers to pursue riskier strategies like increased real earnings management (Huang et al., 2020).

Finally, our study expands banking risk management literature by examining biodiversity risk integration. This risk type differs from credit risk, political uncertainty, climate risk, and others (Altman, 1968; Altman and Kishore, 1996; Pan et al., 2018; Akins et al., 2020; Kang et al., 2021; Gad et al., 2024; Ginglinger and Moreau, 2023). Our findings demonstrate tangible financial implications and heterogeneous effects of borrowing firms' biodiversity risks, providing policy implications for financial institutions' risk management practices.

2. Literature Review and Hypothesis Development

2.1 Sustainable Investing

Financial institutions are pivotal in the realm of sustainable investing, a domain that transcends niche strategies to permeate mainstream investment practices (Liang et al., 2022; Hartzmark and Sussman,2021). This trend indicates a growing recognition of the dual benefits of sustainable investing: aligning with environmental and social values while also seeking profitable returns.

Impact investors, including venture capital and growth equity funds, are particularly focused on generating not only financial gains but also measurable positive impacts on society or the environment (Barber et al. 2021). Investors have to trade off the benefits and costs of financial gains and ESG outcomes. For example, some hedge funds that endorse responsible investment have to sacrifice return and cater to investors' preferences (Liang et al., 2022). Nevertheless, the continuous attention from investors generates a large impact on firms' decisions. For example, Ilhan et al. (2023) have shown that institutional investors value and demand firm climate risk disclosure, which further imposes a positive impact on firms' disclosure of climate issues. Investors' continued attention to climate change drives companies to embrace green strategies and mitigate negative publicity to enhance their financial performance (Flammer, 2015; Krüger, 2015).

Apart from the equity market, bond markets embrace sustainable investing, with an increasing issuance of green bonds aimed at funding eco-friendly initiatives. Flammer (2021) shows that the debut of green bonds is met with a favorable stock market reaction, particularly for issuers who are first-timers or have secured third-party validation. Such bonds are seen as a reliable indicator of a company's dedication to environmental responsibility and are instrumental in achieving tangible environmental improvements (Flammer, 2020). The escalating interest in green bonds mirrors the wider movement to incorporate ESG factors into fixed-income investment strategies.

Banks also re-evaluate their lending criteria by considering sustainability (Martini et al., 2024; Sautner et al., 2024; Roncoroni et al., 2021; Bu et al., 2023). Huang et al. (2022) demonstrate that firms with significant climate risk exposure are more likely to face stringent loan terms unless they adopt robust climate risk management strategies. Reghezza et al. (2022) provide evidence that European banks have redirected their credit away from polluting entities post the Paris Agreement, underscoring the profound influence of regulatory policies and green initiatives on banking practices. Recent banking studies show that lenders not only select borrowers based on their ESG alignment but also influence and discipline the borrowers to enhance their ESG performance (Houston and Shan, 2022).

In essence, the convergence of equity and bond market dynamics, coupled with the proactive stance of banks, is fostering a financial ecosystem that not only acknowledges but also actively promotes sustainable investing, thereby encouraging corporate sustainability and environmental responsibility.

2.2 Biodiversity Risk

The issue of biodiversity risk is complex and multifaceted, with implications for several different areas, including the ecological, economic, and social. It refers to the possibility of species extinction, habitat destruction, and the deterioration of ecosystem services. The loss of biodiversity can have notable economic and social implications, including reduced productivity, increased vulnerability to pests and diseases, and the decline of ecosystem services that are vital for human well-being and economic development (e.g., Heal, 2004; Dasgupta, 2021; WEF, 2023). For example, Frank and Sudarshan (2024) have shown that the collapse of keynote species in India has increased the human mortality rate due to the negative shock to sanitation. Raynor et al. (2021) document that restoring the wolf populations reduces the deer-vehicle collisions in Wisconsin, yielding an economic benefit that is 63 times greater than the cost of verified wolf predation on livestock. Similarly, Dasgupta (2021) pointed out that in areas where fishing is not regulated or is poorly managed, fish stocks can be rapidly depleted, leading to the collapse of entire marine ecosystems due to overfishing and negatively affecting the fishing industry. To summarize, the biodiversity issue is closely related to the social and economic welfare of human beings, as our economies are embedded within nature and not external to it.

Biodiversity risk is closely interconnected with global warming and climate change, but it also has distinct characteristics. First, biodiversity risk centers on the variety and variability of life on Earth, including the interdependence of species and their habitats. In contrast, climate risk primarily focuses on changes in climate systems, such as temperature rise, sea-level changes, and altered precipitation patterns, resulting from greenhouse gas emissions and other human activities that affect the climate. Second, the policies and regulations surrounding biodiversity risk often involve conservation efforts, habitat restoration, and the sustainable use of natural resources. For example, the UK's 2021 Environmental Bill introduces mandatory goals for nature conservation, water and air quality, and waste management to be achieved by 2030. On the other hand, climate risk mitigation strategies typically revolve around reducing carbon emissions, investing in renewable energy, and promoting low-carbon technologies (Hong et al., 2020; Dasgupta, 2021).

Given the distinct and fundamental differences between biodiversity risk and climate risk, studying biodiversity finance is both timely and crucial. Understanding how financial institutions can effectively integrate biodiversity risk into their decision-making processes and risk management frameworks is essential for addressing the unique challenges posed by biodiversity loss and promoting sustainable economic development. Global biodiversity finance is estimated at USD 78-91 billion per year. Governments allocate an estimated USD 500 billion annually towards support that may have detrimental impacts on biodiversity (OECD, 2020). This highlights the need to redirect financial flows towards biodiversity conservation and restoration efforts.

Similar to climate change, the financial risks associated with biodiversity loss can be broadly categorized into two types: physical risk and regulatory (transition) risk. Physical risk arises when biodiversity loss causes damage to ecosystems that negatively impact business operations and productivity. For example, the decline in insect populations can have adverse consequences on crop yields, which can affect production processes along the supply chain. These realized losses can be reflected in the financial balance sheets and linked to market or credit risks (OECD, 2021). Regulatory risk arises from stricter public policies and government regulations aimed at forcing companies to adopt sustainable business practices or limiting the exploitation of land and sea resources. Non-compliance with such regulations can trigger liability risks, including litigation by environmentalists, regulatory penalties, and increased insurance costs.

2.3 Biodiversity Risk and Bank Lending Decision

We propose that firms' biodiversity risk is associated with higher bank loan spreads. To better illustrate, we categorize borrowing firms into two distinct categories based on their involvement in biodiversity losses. The first category, referred to as "Perpetrators," comprises firms engaged in economic activities that potentially harm biodiversity. These Perpetrators mainly face regulatory or transition risks arising from regulations and policies that aim to prevent biodiversity loss (Battiston et al., 2021). Oil and mining companies are prime examples, as their drilling and mining activities significantly impact wildlife habitats. Consequently, these firms face potential future litigations and the imposition of new conservation regulations and policies, which could curtail their business opportunities, operating profitability, and loan repayment capability. The second category, known as "Victims," encompasses firms that experience adverse effects on their business operations and profitability due to physical risks associated with a decline in biodiversity (Huang et al., 2022). For example, the loss of marine biodiversity and degradation of ecosystem services can significantly impact the long-term profitability of sustainable fishing enterprises or water supply companies.

The cumulative impact of these risks and their associated costs can exacerbate the financial stability of such firms and diminish their capacity to service their debt obligations (Battiston et al. 2021; Ivanov et al., 2024). Hence, we hypothesize that banks also consider borrowers' biodiversity risk, potentially leading to increased ex-ante pricing in their lending strategies.

However, it remains an empirical question whether banks care about the biodiversity risks of their borrowers to the extent that can be discerned in the loan spreads. As previous research has shown, there is a growing preference among investors and consumers for environmentally friendly options, which could outweigh the risk premium (Dai et al., 2021; Pástor et al., 2021, 2022). Firms that disclose biodiversity risks in their financial reports could be the ones that are more conscious of biodiversity issues. Accordingly, banks might use lower prices for such firms to demonstrate their dedication to sustainable practice if banks have a green taste. Another possibility is that, if the financial impact of biodiversity risk on a borrower's health is not substantial, banks may choose to overlook this risk. In these instances, biodiversity risk may not be a key consideration in the banks' lending strategies.

Evidence from equity markets is still nascent and mixed. Coqueret and Giroux (2023) document that the biodiversity risk premium has hovered near zero for the past decade and has even turned negative recently, using Iceberg DataLab data. Garel et al. (2024), relying on the same source, find a pronounced biodiversity footprint premium emerging after the Kunming Declaration in October 2021. Besides, while existing studies rely on emerging datasets like Iceberg DataLab or S&P Nature & Biodiversity Risk, their methodological limitations (e.g., mechanical estimation, limited time coverage) may constrain the analysis of banks' historical responses to biodiversity risk. This motivates our alternative approach to measuring biodiversity exposure, as detailed in Section 3.1.

3. Data and Research Design

3.1 Data Source and Sample Selection

We obtain the data on firm-level biodiversity risk from Giglio et al. (2023), which is based on textual analysis of firms' 10-K filings from 2004 to 2019. Giglio et al. (2023) use the biodiversity dictionary to identify the biodiversity-related sentences that contain the following biodiversity-related terms: biodiversity, ecosystem(s), ecology (ecological), habitat(s), species, (rain)forest(s), deforestation, fauna, flora, marine, tropical, freshwater, wetland, wildlife, coral, aquatic, desertification, carbon sink(s), ecosphere, and biosphere. The examples are illustrated in Appendix B. Their biodiversity count score is a dummy variable that equals one if a company's 10-K statement includes a minimum of two sentences that pertain to biodiversity, and zero otherwise. The measurement obtained from the 10-K report is at the firm-year level, which allows for a better capture of firms' self-assessment of biodiversity risks across firms and years.

While we acknowledge potential limitations of the measures derived from 10-K reports, such as self-reporting issues, biodiversity risks disclosed in these filings are more likely to reflect financially material risks that warrant attention from banks.[3] In contrast, the Iceberg DataLab measure is mechanically derived from input–output tables and thus subject to estimation errors. The S&P Nature & Biodiversity Risk dataset in recent working papers covers twenty thousand firms globally (e.g., Canipek et al., 2024; Degl'Innocenti et al., 2025). However, its coverage commences only in 2021. Given that firms have confronted biodiversity risks for decades and increasingly disclosed them in 10-K filings (Heal, 2004; Giglio et al., 2023), banks should have been aware of and responsive to such risks long before 2021. We, therefore, further supplement the existing literature on biodiversity risk by examining how firm-disclosed biodiversity risk is associated with bank lending decisions and by illuminating the nuanced role banks play in loan pricing over a longer time span.

We obtain loan pricing data from the syndicated bank loans in the DealScan Database. Consistent with established methodologies in the prior research, we determine the loan tranche spread by calculating the difference between the coupon spread over LIBOR and the annual fee on the drawn loan amount, commonly referred to as the "all-in-drawn-spread" within the DealScan Database. We then divide this figure by 100 to normalize the spread (Drucker and Puri, 2005; Bharath et al., 2011; Kang et al., 2021). In addition to the loan spread, we also consider other loan characteristics such as maturity, loan amount, utilization of collateral, financial covenants, and the intended purpose of the loan, all of which are sourced from the DealScan Database.

The biodiversity lawsuit data is from the Climate Change Litigation Databases provided by Columbia Law School and the Columbia Climate School.[4] This comprehensive dataset

[3] We adopt state-level biodiversity litigation as an exogenous shock to alleviate the concern.
[4] https://climatecasechart.com/us-climate-change-litigation/

encompasses U.S. litigations for a wide range of legal claims, including those based on federal statutes, constitutional provisions, and state laws. Our analysis focuses on cases related to biodiversity issues such as water conservation, wildlife habitats, and endangered species, with an emphasis on those at the state level or those with significant statewide impact. By examining State Impact Assessment Laws and Federal Statutory Claims, we have identified 10 cases and four affected states that meet our criteria in our sample period. We employ the petition of these cases as an exogenous shock to the firms' attention to biodiversity risk management. A detailed summary of these cases is presented in Appendix C. To ensure the accuracy of these cases, we cross-reference them with additional litigation databases, including the CEQA portal and Casetext, to verify the litigation details and ascertain the event year for the initial petition of each case.[5]

Firms' fundamental financial variables are obtained from COMPUSTAT. The ownership ratio of ESG-oriented investors is derived from the 13F filings and the MSCI KLD database. Our firm-level climate change risk measures are sourced from Sautner et al. (2023), while the firms' environmental risks are taken from the RepRisk Database.

We extract 321,325 observations from the DealScan Database from 2004 to 2019, which encompass 153,289 unique loan tranches.[6] We employ the DealScan-Compustat link file provided by Chava and Roberts (2008) to match these observations based on borrowers' IDs. We then use firms' GVKEY to merge this dataset with quarterly financial fundamentals from COMPUSTAT and the biodiversity risk measures. To ensure a robust analysis, we limited our sample to observations with complete information on both loan characteristics and firm

[5] https://casetext.com/case/ctr-for-biological-diversity-v-cal-fish-game-commn; https://ceqaportal.org/ceqacase.cfm?cq_id=1612

[6] The data source of biodiversity risk covers till the year 2020. However, we exclude the year 2020 as the mean spread is 2.42, increasing 20% compared to the sample mean before COVID-19. The results are robust including the year 2020.

fundamentals. This restriction reduces the size of our final sample to 21,497 observations across 573 unique borrowers.

3.2 Research Design

3.2.1 Baseline Regression

To examine whether banks incorporate borrowers' biodiversity risk into their lending decisions, we estimate the following regression model, presented as Equation (1):

$$Spread_{i,j,l,t} = \beta_0 + \beta_1 BIO\_RISK_{i,t} + \theta LoanControl_{i,j,l,t} + \gamma BorrowerControl_{i,t} + FixedEffects + \varepsilon_{i,j,l,t} \quad (1)$$

Spread is defined as the coupon spread over LIBOR on the drawn amount plus annual fee ("all-in-spread down" or AISD in Dealscan) at the time of loan origination, divided by 100. The indices *i,j,l,t* denote borrower *i*, lender *j*, loan *l*, and year *t*, respectively. The indices *i,j,l,t* denote borrower *i*, lender *j*, loan *l*, and year *t*, respectively. We follow Kang et al. (2021) to regress the spread in year *t* on the firm's biodiversity risk in year *t*. *BIO_RISK* is a binary variable representing the explicit mention of biodiversity risk within a firm's 10-K reports. This variable is coded as one if the company's 10-K filing contains at least two sentences related to biodiversity, and zero otherwise.

Following Gad et al. (2023), we perform our regression analysis at the tranche-bank level, recognizing that a single borrower may engage in multiple loan contracts with different banks within the same year. Given that all the participating banks' characteristics, not only the ones from lead arrangers, could influence loan pricing (Gad et al., 2023), we utilize the tranche-bank structure and control for lender-fixed effects and year-fixed effects. We incorporate borrower and year-fixed effects to control for unobserved, time-invariant characteristics of borrowers and broader macroeconomic trends.[7] We add loan-type fixed effects to compare the variations

[7] The results are robust by adding industry fixed effects, instead of borrower fixed effects

within each type of loan. Furthermore, in the expanded models, we introduce joint fixed effects for lender × year and lender × borrower relationships to account for the time-variant attributes of individual banks and the specific dynamics of each lender-borrower pair. Standard errors are clustered at the firm level.

We also follow the prior literature (e.g., Kang et al., 2021) to include both loan control variables and borrowers' control variables that could potentially affect the loan price. Loan characteristics include maturity (*LOG_MATURITY*), loan amount (*LOG_LOAN_AMOUNT*), the usage of collaterals (*COLLATERAL*), financial covenants (*FIN_COV*), and loan purposes (*LOAN_PURPOSE*). The control variables for borrowers' characteristics include firm size, the natural logarithm of market value (*Ln_MV*), leverage ratio (*LEV*), Property, plant, and equipment scaled by assets (*PPE*), profitability (*ROA*), market-to-book ratio (*MTB*), stock return volatility (*RET_VOL*) and bankruptcy risk measured by o-score (*O_SCORE*). The details of variable construction can be found in the Variable Definition of Appendix A.

To establish robustness, we include different sample constructions. As the biodiversity risk measure is at the firm-year level, in the robustness tests, we also aggregate the loans' data at the firm-year level, taking the average of the loan spreads for borrower *i* in year *t*. We also add additional control variables, such as climate risk or environmental risk, to show the distinct effect of biodiversity risk on loan pricing beyond these related risks.

3.2.2 Biodiversity Litigation

To strengthen the causal inference in our study, we utilize state-level biodiversity lawsuits as an exogenous shock. This approach is designed to account for the attention garnered by companies headquartered in the affected states and the subsequent reduction in their biodiversity risk. It is crucial to acknowledge the potential impact of omitted variables, such as macroeconomic conditions, that could concurrently influence both a firm's biodiversity risk and bank financing decisions. Moreover, there is a possibility of reverse causality, where financial constraints could affect a firm's management of biodiversity risk. Firms may deprioritize biodiversity risk management in favor of securing financing, particularly when facing challenges in accessing capital, which could lead to increased biodiversity risks (Kim and Xu, 2019). In turn, higher bank financing costs may exacerbate a firm's biodiversity risk.

In the United States, the involvement in biodiversity lawsuits, despite the uncertainty of outcomes until a final ruling, attracts significant public attention and intensifies scrutiny (Rodríguez-Garavito and Boyd, 2023; Zhou and Ding, 2023). The prior research has demonstrated that community shocks, including litigation risks, can influence firm decision-making, particularly when managers are aware of such risks (Levy et al., 2018; Huang et al., 2020; Chen et al., 2021). Consequently, the initiation of state-level lawsuits can be considered relatively exogenous to the firm-specific decisions regarding biodiversity risk management and bank loan outcomes, providing a plausible setting to identify the causal effects of biodiversity risk on financing costs.

Empirically, we adopt a staggered difference-in-differences (DID) design based on state-level biodiversity litigation. We conduct the regression analysis as Equation (2) below:

$$Spread_{i,j,l,t} = \beta_0 + \beta_1 BIO\_LAWSUIT_{i,t} + \theta LoanControl_{i,j,l,t} + \gamma BorrowerControl_{i,t} + FixedEffects + \varepsilon_{i,j,l,t} \quad (2)$$

BIO_LAWSUIT equals one if the borrower's headquarters is located in the state affected by the biodiversity lawsuit after the initiation of the litigation; zero otherwise. For instance, for firms headquartered in California, *BIO_LAWSUIT* equals one following the initiation year of 2007 for the case *Center for Biological Diversity v. California Department of Fish and Game Commission*. Thus, *BIO_LAWSUIT* captures both the treatment and post-effects as we add firm and year fixed effects. The control variables included in our analysis are consistent with those utilized in Equation (1). Given that biodiversity lawsuits are expected to prompt a reduction in firms' biodiversity risk, which in turn could lead to a decrease in loan spreads, we expect β_1 in Equation (2) to be negative.

Our analysis is centered on the headquarters as the pivotal location affected by biodiversity lawsuits, given that senior management, who are responsible for a firm's risk management and sustainability strategies, are typically based there. We use the lawsuit initiation year as the event year because it marks the initial public disclosure of the litigation, which is when it becomes a salient consideration for the affected borrowers. To substantiate our assumption regarding the impact of biodiversity litigation on corporate behavior, we conduct an analysis that evaluates how the initiation of these lawsuits influences the firm's biodiversity risk management, using a firm-year sample reported in Appendix D.

3.2.3 Descriptive Statistics

Figure 1 illustrates the year-on-year trend in the percentage of U.S. public firms mentioning biodiversity risk within their annual 10-K reports. This metric, calculated at the firm-year level before merging the dataset with the DealScan Database, demonstrates a notable upward trajectory over the sample period. Initially, in 2004, only about 1% of firms referenced biodiversity risk in their reports, which has risen to approximately 4% by 2019. This upward trend indicates a growing emphasis on biodiversity risk management among U.S. public corporations, reflecting an increased awareness and response to environmental concerns within the business community.

Table 1 presents the summary statistics for the variables utilized in our baseline regression analysis. The mean loan spread (*Spread*), measured in basis points (100bp), is around 2. The natural logarithm of loan maturity, expressed in months, is 3.876, which corresponds to an average loan term of approximately 48 months. The natural logarithm of the loan amount stands at 5.449, translating to a mean loan size of $232.5 million. The usage of collateral in loan agreements is prevalent, with 40% of loans featuring collateral. Similarly, financial covenants are included in 36% of the loan contracts. Loans designated for Mergers and Acquisitions (M&A), management buyouts, and recapitalization purposes constitute 15% of the sample.

In Table 2, we examine the relationship between our measure of biodiversity risk and other indicators of climate change and environmental risk by calculating pairwise correlations. *BIO_REG_RISK* is regulation (i.e., transition) risks related to biodiversity issues. *BIO_PHY_RISK* is physical risks related to biodiversity issues. The analysis reveals that while there is a positive correlation between the biodiversity risk measure and climate change risk, the extent of overlap is modest, with a correlation of 0.025. Additionally, the correlation between *BIO_RISK* and the environmental risk metric from the RepRisk database (*ENV_RISK*) is only 0.15. These findings suggest that biodiversity risk is a distinct construct from other forms of climate change and environmental risks, justifying its separate consideration in our study.

4. Results

4.1 Main Results: Biodiversity Risk and Loan Spread

The baseline regression results are presented in Table 3. In Column (1), we add borrower and year fixed effects. In Column (2), we add borrower, loan type, year, and lender fixed effects. In all the other analyses, we also follow this model specification. In Column (3), we add borrower, loan type, and lender × year fixed effects to consider the banks' time-variant characteristics across years. In Column (4), we further add lender × borrower fixed effects to consider the endogenous match between the borrower and the bank.

The coefficients on *BIO_RISK* for the first three columns (Columns 1-3) are all positive and significant at the 1% level. The coefficient in Column (4) remains positive at the 10% level even after controlling for the lender and borrower match. In terms of economic magnitude, taking Column (2) as a benchmark, firms with biodiversity risk are subject to an average loan spread that is 48.4 basis points higher compared to firms without such risk. From Columns (1) to (4), the estimated economic impact ranges from 30.3 to 51.3 basis points, which is a non-trivial effect.

For control variables, larger loan amounts and the inclusion of financial covenants within loan agreements are associated with a reduced loan spread. This finding may reflect a lower perceived risk by lenders when loans are collateralized with larger amounts or when financial covenants are in place to protect their interests. Conversely, the use of collateral in loan agreements and loans intended for takeovers or similar purposes is positively associated with higher loan spreads. This positive association could be attributed to the increased risk perceived by lenders in transactions involving mergers and acquisitions, which often involve greater uncertainty and financial leverage. The magnitudes and directions of these effects are consistent with those reported in previous literature (Kang et al., 2021; Huang et al., 2022). Additionally, we find that firm-level characteristics exhibit a weaker association with bank loan decisions after incorporating firm and year fixed effects. This suggests that much of the variability in loan spreads could be attributed to firm-specific factors captured by these fixed effects.

4.2 Mechanism Tests: Nuanced Role of Bank

To better understand the role of banks in biodiversity financing, we conduct mechanism tests to examine whether and when banks differentiate between firms' regulatory risk and physical risk.

4.2.1. Perpetrators vs. Victims

We first categorize biodiversity risk into regulatory risk and physical risk based on our hypothesis development regarding Perpetrators and Victims. To test whether banks consider these two types of borrowers differently in terms of loan cost, we regress loan spreads on regulatory biodiversity risk (*BIO_REG_RISK*) and physical biodiversity risk (*BIO_PHY_RISK*). The regression results are presented in Table 4, Column (1). The coefficients on *BIO_REG_RISK* and *BIO_PHY_RISK* are both positive and significant, indicating that banks account for both types of risks in their lending decisions.

Specifically, the coefficient on *BIO_REG_RISK* is 0.410, while the coefficient on *BIO_PHY_RISK* is 0.687. Although the economic magnitude of *BIO_PHY_RISK* is twice that of *BIO_REG_RISK*, the p-value for the equality test on the two coefficients is not statistically significant at conventional levels. This suggests that banks consider both regulatory and physical risks in their lending decisions.

4.2.2. Sin Banks' Reactions toward Perpetrators and Victims

While both physical and regulatory risks are associated with higher loan spreads, banks may exhibit nuanced differences in their treatment of these risks. Specifically, we examine how banks frequently criticized for financing sectors that drive biodiversity loss (Sin Banks) react differently to Perpetrators and Victims in terms of loan pricing. Sin Banks such as Bank of America, Citigroup, etc., are experienced in dealing with the "sin loans" for firms as Perpetrators of biodiversity losses.[8] We propose that since these banks have been financing the Perpetrators, they have a better capability to distinguish Perpetrators from Victims and charge a higher price for the regulatory risk compared to the physical risk.

To identify the Sin Banks, we use data from the Bankrolling Extinction, which ranks the top 10 banks that are criticized for financing biodiversity loss activities. Specifically, we define *SIN_BANK* as the number of lead arrangers or co-lead arrangers within a syndicated loan that

[8] https://www.banktrack.org/article/bankrolling_extinction_the_top_10_banks_financing_biodiversity_loss

are among the top 10 banks. The results are presented in Column (2) of Table 5. The interaction term between *BIO_REG_RISK* and *SIN_BANKS* yields a positive and statistically significant coefficient at the 1% level, indicating that top biodiversity financiers increase loan spreads for Perpetrators. Conversely, the interaction term between *BIO_PHY_RISK* and *SIN_BANKS* yields a negative and statistically significant coefficient, suggesting that these banks reduce loan spreads for Victims. Additionally, the equality test confirms that the coefficients for these interaction terms are statistically different at the 1% level.

These findings indicate that such Sin Banks treat Perpetrators and Victims differently. Although both regulatory and physical risks are associated with higher loan costs, the Sin Banks charge higher premiums for Perpetrators while showing less concern for Victims. In conjunction with the results in Section 4.4.2 (Table 7), which show that the government provides tax reductions for Victims, one plausible explanation why such Sin Banks would charge lower premiums for Victims is their proficiency in distinguishing the Perpetrators from Victims.

4.2.3. Relationship Lending

In this section, we examine whether relationship lending can mitigate the positive association between biodiversity risk and loan spreads. The existing literature suggests that relationship lending enhances banks' access to borrower-specific information through private channels, thereby enabling more effective monitoring of borrowers' financial health (Chernenko and Sunderam, 2014; Lin et al., 2012). This enhanced understanding allows banks to better manage risks, potentially including those related to biodiversity. Consequently, relationship lending may serve as a substitute for traditional risk management practices by providing banks with the necessary information to assess and mitigate biodiversity-related risks. However, it remains unclear whether relationship lending differentiates between physical and regulatory risks. To quantify the extent of relationship lending, we adopt the methodology proposed by Lin et al. (2012), which is based on the history of lending relationships between banks and borrowers. Specifically, we use a dummy variable termed *RELA_LENDING*, which is assigned a value of one if the bank has served as the lead bank for a particular borrower at any time within the preceding five years and zero otherwise.

The results presented in Column (3) of Table 4 show that the coefficient on the interaction term between *BIO_PHY_RISK* and *RELA_LENDING* is negative and statistically significant at the 1% level. In contrast, the interaction term between *BIO_REG_RISK* and *RELA_LENDING* is insignificant. The equality test confirms that these two coefficients are statistically different at the 1% level. These findings suggest that relationship lending mitigates the impact of physical risks but not regulatory risks.

A probable explanation is that physical risk is relatively fixed and difficult for firms to manage, whereas regulatory risk can be more dynamic and subject to policy changes. Therefore, during repeated lending, the initial premium associated with physical risk diminishes, but this is not the case for regulatory risk. In conclusion, banks exhibit nuanced differences in their treatment of Perpetrators and Victims, considering the boundary conditions of the two types of borrowers.

4.3 Identification: Biodiversity Litigation

Table 5 delineates the impact of biodiversity litigation on bank loan spreads, employing the regression framework outlined in Equation (2) and incorporating the same set of fixed effects as specified in Column (2) of Table 3. The coefficient attributed to the variable *BIO_LAWSUIT* is negative and statistically significant at the 5% level. Firms headquartered in states embroiled in biodiversity litigation exhibit a loan spread that is 45.2 basis points lower than firms in non-affected states. The finding implies a response by management within affected firms to proactively mitigate their biodiversity risk exposure following the initiation of litigation. This risk mitigation behavior is posited to result in reduced perceived credit risk by banks (irrespective of whether banks pay more attention to biodiversity risk), thereby translating into a lower loan spread and a consequent decrease in the cost of bank loan financing.

In Panel B of Table 5, we conduct a pre-trend analysis to identify the existence of any differences in loan spreads between the treated and control groups before the initiation of the biodiversity lawsuits. *BIO_LAWSUIT (t−1)* is a binary indicator that equals one if the firm's state is anticipated to be involved in a biodiversity lawsuit within the subsequent year. Similarly, *BIO_LAWSUIT (<=t−3)* indicates a lawsuit within three years or later. The coefficient on *BIO_LAWSUIT (>=t+3)* is normalized and serves as a benchmark. We find that the pre-treatment coefficients do not exhibit statistical significance.

To validate the shock of biodiversity lawsuits to firms' biodiversity risk, we perform a panel regression analysis at the firm-year level by regressing the *BIO_RISK* measure against the *BIO_LAWSUIT* indicator. The sample encompasses public firms with available 10-K reports, spanning from 2004 to 2019. The result of this analysis is shown in Appendix D. Consistent with our hypothesis, the commencement of biodiversity lawsuits is associated with a reduction in the affected firms' biodiversity risk. This finding reinforces the notion that biodiversity litigation can serve as an exogenous shock that diminishes borrowers' biodiversity risk, thereby influencing bank lending decisions.

4.4 Additional Analysis

4.4.1 Additional Controls of Climate Change Risk and Environmental Risk

In our extended analysis, we introduce further controls to account for climate change risk and environmental risk. These controls are designed to provide a more comprehensive assessment of various types of conceptually related risks that may influence bank lending decisions. Specifically, we incorporate the climate change risk measure (*CC_RISK*) developed by Sautner et al. (2023), which is derived from a textual analysis of conference call transcripts. For comparison with the biodiversity risk measure, we use a dummy variable of the climate risk measure.[9] Additionally, we utilize environmental risk data (*ENV_RISK*) from the RepRisk Database. This metric is calculated by multiplying the risk score provided by RepRisk with the relevant environmental percentage. The inclusion of these control variables leads to a reduction in our sample size due to data availability, which is the key reason why we do not have these control variables in our main analysis.

Table 6 shows that, after incorporating controls for both climate change and environmental risks into our regression model, the coefficient on our biodiversity risk (*BIO_RISK*) remains positive and statistically significant. This result highlights that biodiversity risk is a distinct and relevant factor in bank loan pricing, independent of other environmental and climate-related risks.

4.4.2 Tax Deduction for Victims

Table 7 investigates the relationship between firms' tax payable and biodiversity risk. The U.S. government has made significant efforts in ecological tax planning to address biodiversity loss. For example, financial aid for constructing water and air purification facilities and pollution reduction facilities is excluded from the taxable income base.[10] Additionally, firms affected by biodiversity-related physical risks are more likely to receive financial assistance from governmental, non-governmental organizations (NGOs), or other private financing projects (Flammer et al., 2024), which is associated with tax deduction. Consequently, firms with biodiversity physical risk should have lower tax liabilities.

Consistently, the result in Table 7 shows that Victim firms have lower tax payables compared to Perpetrator firms. In Column (1), the coefficient on the mixed measure of

[9] Nevertheless, using continuous measure from Sautner et al. (2023) yields similar results. Controlling for regulation and physical climate change risks yields similar results.
[10] https://www.epa.gov/sourcewaterprotection/source-water-protection-funding

biodiversity risk is insignificant. In Column (2), the coefficient on *BIO_PHY_RISK* is negative at a 5% level, while the coefficient on *BIO_REG_RISK* is insignificant. The difference between the two coefficients is significant. Combining this with the findings in Table 4, which indicate that banks are more "lenient" towards Victim firms than Perpetrator firms, it is plausible that Victim firms receive more support from alternative financing sources such as the government through tax deduction.

4.4.3 Interest Expense

In this section, we examine the relationship between biodiversity risk and firms' interest expense. To ensure generalizability, the analysis is not limited to syndicated bank loan data but includes all public firms and is conducted at the firm-year level. The interest expense is scaled by total assets. Results in Panel A of Table 8 indicate that biodiversity risk (*BIO_RISK*) is positively and statistically significantly associated with interest expenses at the 5% level. When disaggregating biodiversity risk into regulatory and physical components, the findings reveal that regulatory risk drives the observed effect, whereas physical risk exhibits no significant association. Panel B compares biodiversity risk with climate change risk. While biodiversity risk remains positively linked to heightened interest expenses, climate change risk does not demonstrate a statistically significant relationship. This pattern persists when isolating regulatory risk from physical risk.

The results collectively indicate that firms facing biodiversity risk experience higher borrowing costs, particularly when this risk stems from regulatory concerns. Unlike the findings in Table 4, where banks demonstrate concern for both regulatory and physical risks, other general lenders, such as bondholders, primarily focus on regulatory risk.

4.4.4 Robustness Tests

We perform two robustness checks to ensure the reliability of our results. These checks involve the use of alternative specifications for the dependent variables, as well as different firm-year sample structures. The findings from these tests are compiled in Table 9. In Panel A, we utilize an alternative calculation for the net spread in Ivashina (2009), which is determined by subtracting the up-front fee from the spread. The qualitative results from this approach are consistent with those initially presented in Table 3. Lastly, we modify our sample structure to examine the relationship between a borrower's biodiversity risk and the average cost of the loan at the firm-year level. This entails aggregating the spread data at the firm level to serve as our dependent variable, resulting in a sample of 1,207 unique firm-year observations. Concurrently, we also aggregate the other loan control variables at the firm level. The results, as shown in Panel B, indicate that the coefficient on *BIO_RISK* remains positive and significant at the 5% level.

4.4.5 Other Cross-sectional Tests

In the next two sections, we shift our focus to how the characteristics of the borrowers affect the relationship between biodiversity risk and bank loan spreads. We conjecture that borrowers' green governance practices could alleviate banks' concerns regarding biodiversity risk. The "green governance" refers to the ESG considerations that are prioritized by institutional investors. Such governance practices act as a proxy for the risk management efforts undertaken by borrowers (Azar et al., 2021), potentially reducing the need for banks to engage in extensive monitoring of borrowers' biodiversity risks. Consequently, firms with a higher presence of ESG-oriented investors are more likely to reduce their biodiversity risk, leading to lower loan spreads.

In our assessment of borrowers' green governance, we adhere to the methodology employed by Cao et al. (2023), who use the institutional ownership ratio combined with the value-weighted ESG scores from the MSCI database of their portfolio holdings. Column (1) of Appendix E presents the results. The interaction term between *BIO_RISK* and *ESG_IOR* exhibits a negative and statistically significant coefficient at the 1% level. This result suggests that the presence of green governance practices among borrowers acts as a mitigating factor for banks when assessing biodiversity risk, effectively serving as a substitute for traditional risk management strategies in the context of bank loans.

We also explore how borrowers' innovation affects our main findings. Specifically, we examine whether banks would be more lenient and supportive of borrowers' innovative activities, even if they face high biodiversity risks. To combat the long-term effects of ecosystem destruction, firms need to invest in green and clean technologies, which potentially entail higher expenses for research and development. We do not have a clear prediction for this test, as banks may find it either more costly or risky to provide financing for firms with more intensive green innovation. However, this exercise helps us better understand the extent to which banks are willing to support innovative, environmentally sustainable practices of their borrowers with biodiversity risks.

We adopt a borrower's research and development (R&D) expenses as a proxy for their innovative efforts and use the decile ranking of R&D expenses (*R&D_RANK*) to mitigate the influence of outliers and account for the skewness inherent in raw R&D expenditure data. A higher decile ranking indicates a greater commitment to innovation. In our analysis, we create an interaction term between *BIO_RISK* and *R&D_RANK* and include it in a regression model. Column (2) shows that the coefficient on the *BIO_RISK* × *R&D_RANK* interaction term is negative and statistically significant. This result implies that while banks may impose a higher loan spread on firms with greater biodiversity risk, they also demonstrate support for the innovative endeavors of these firms.

Furthermore, we investigate the consequences of increased loan spreads on firms' green innovation outcomes, particularly in relation to their biodiversity risk. We regress firms' green innovation output, measured by green patents, on the interaction between biodiversity risk (*BIO_RISK*) and the average loan spread (*Spread_AVG*). To ensure comparability, our analysis is confined to firms that have filed for at least one patent in year *t*. To address the right-skewed distribution of the green patent data, we employ the natural logarithm transformation of the number of green patents filed by the firm (*Ln_GreenPatent*). The green patents are identified using the patent data source developed by Kogan et al. (2017) and the patent classification system from the OECD.[11]

As detailed in Appendix F, the coefficient on the interaction term *BIO_RISK* × *Spread_AVG* is found to be negative and statistically significant at the 1% level. This result implies that for firms with higher biodiversity risk, banks that impose a higher loan spread as a risk premium may inadvertently impede the firm's green innovation efforts, as evidenced by a diminished output of green patents. Conversely, the findings suggest that if banks were to offer more favorable loan terms to firms with biodiversity risk, this could potentially stimulate an increase in the firm's green innovative output. Such banking credit would foster greater productivity in the development of green patents to address the biodiversity issue.

5. Conclusion

The study underscores the critical role of biodiversity risk in the financial sector, particularly in bank lending decisions. The findings indicate that biodiversity loss is not only an environmental concern but also a significant financial risk that can affect the stability of the financial system and the economy at large. Our research contributes to the literature by providing novel evidence that banks price biodiversity risk into their lending decisions. More importantly, we show the nuanced roles of banks for firms identified as Perpetrators or Victims.

Our empirical analysis, utilizing syndicated loan data and firm-level biodiversity risk measures, reveals that the acknowledgment of biodiversity risk in financial reporting is

[11] The source of the patent dataset and green patent. https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data; https://www.oecd-ilibrary.org/environment/measuring-environmental-innovation-using-patent-data_5js009kf48xw-en

associated with a 30.3 to 51.3 basis-point increase in loan spreads. This relationship holds even after controlling for other climate and environmental risks. The use of state-level biodiversity lawsuits as an exogenous shock further strengthens the causal inference between biodiversity risk and bank loan pricing.

In the mechanism test, we show that both regulatory and physical biodiversity risks can lead to higher loan spreads. However, banks being criticized for financing sectors that drive biodiversity loss, referred to as "Sin Banks," tend to charge higher spreads on loans to Perpetrators. A plausible explanation is that Sin Banks would charge lower premiums for Victims because of their proficiency in distinguishing the Perpetrators from Victims who can receive tax benefits and support from governments and other financing sources.

Our study responds to the call for further research in the emerging field of biodiversity finance, thereby addressing a significant gap in the current academic discourse. Our results also enhance the broader understanding of risk management practices within the banking industry. The integration of biodiversity considerations into banking regulations and risk management frameworks is highlighted as a policy implication. Furthermore, the research methodology employed in this study, which leverages biodiversity litigation as an exogenous shock, introduces an innovative approach to establishing causality in the relationship between biodiversity risk and bank loan pricing.

In conclusion, the recognition and management of biodiversity risk are essential for both financial institutions and borrowing firms. Considering the increasing trend towards biodiversity finance, banks must incorporate biodiversity risk into their lending strategies to mitigate potential financial instability. Meanwhile, firms need to actively manage their biodiversity risk to reduce their cost of capital. Our findings emphasize the need for a collaborative approach between the financial sector and borrowing firms to address the challenges posed by biodiversity loss, ensuring a sustainable and financially stable future.

References

Akins, B., D. De Angelis, and M. Gaulin. 2020. Debt contracting on management. *The Journal of Finance* 75 (4):2095-2137.

Altman, E. I. 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance* 23 (4):589-609.

Altman, E. I., and M. K. Vellore. 1996. Almost everything you wanted to know about recoveries on defaulted bonds. *Financial Analysts Journal* 52 (6):57-64.

Azar, J., M. Duro, I. Kadach, and G. Ormazabal. 2021. The big three and corporate carbon emissions around the world. *Journal of Financial Economics* 142 (2):674-696.

Barber, B. M., A. Morse, and A. Yasuda. 2021. Impact investing. *Journal of Financial Economics* 139 (1):162-185.

Battiston, S., Y. Dafermos, and I. Monasterolo. 2021. Climate risks and financial stability. *Journal of Financial Stability* 54:100867.

Barigozzi, F., and P. Tedeschi. 2015. Credit markets with ethical banks and motivated borrowers. *Review of Finance* 19 (3):1281-1313.

Becker, A., F. E. Di Girolamo, and C. Rho. 2023. Loan pricing and biodiversity exposure: Nature-related spillovers to the financial sector. *JRC Working Papers in Economics and Finance.*

Bharath, S. T., S. Dahiya, A. Saunders, and A. Srinivasan. 2011. Lending relationships and loan contract terms. *The Review of Financial Studies* 24 (4):1141-1203.

Bu, D., M. Keloharju, Y. Liao, and S. Ongena. 2023. Value-driven bankers and the granting of credit to green firms. *Swiss Finance Institute Research Paper* (23-113).

Canipek, A., S. Kundu, J. Tresl, and L. Zimmermann. 2024. Nature-Related Risks in Syndicated Lending. *Available at SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5036091*.

Cao, J., S. Titman, X. Zhan, and W. Zhang. 2023. ESG preference, institutional trading, and stock return patterns. *Journal of Financial and Quantitative Analysis* 58 (5):1843-1877.

Chava, S., and M. R. Roberts. 2008. How does financing impact investment? The role of debt covenants. *The Journal of Finance* 63 (5):2085-2121.

Chen, W., H. Wu, and L. Zhang. 2021. Terrorist attacks, managerial sentiment, and corporate disclosures. *The Accounting Review* 96 (3):165-190.

Cherief, A., T. Sekine, and L. Stagnol. 2022. The market effect of acute biodiversity risk: The case of corporate bonds. *Available at SSRN 4288552*.

Chernenko, S., and A. Sunderam. 2014. Frictions in shadow banking: Evidence from the lending behavior of money market mutual funds. *The Review of Financial Studies* 27 (6):1717-1750.

Coqueret, G., and T. Giroux. 2023. A closer look at the biodiversity premium. *Available at SSRN 4489550*.

Dai, R., H. Liang, and L. Ng. 2021. Socially responsible corporate customers. *Journal of Financial Economics* 142 (2):598-626.

Dasgupta, P. 2021. The economics of biodiversity: the Dasgupta review: *Hm Treasury*.

Degl'Innocenti, M., L. Gai, S. Zhou, and Y. Zhou. 2025. Biodiversity Risks and Global Lending: Balancing Corporate Effort and Country Governance. *Available at SSRN 5279002*.

Drucker, S., and M. Puri. 2005. On the benefits of concurrent lending and underwriting. *The Journal of Finance* 60 (6):2763-2799.

Flammer, C. 2015. Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. *Management Science* 61 (11):2549-2568.

———. 2020. Green bonds: effectiveness and implications for public policy. *Environmental and Energy Policy and the Economy* 1 (1):95-128.

———. 2021. Corporate green bonds. *Journal of Financial Economics* 142 (2):499-516.
Flammer, C., T. Giroux, and G. Heal. 2025. Biodiversity finance. *Journal of Financial Economics* 164:103987
Forbes, 2025, The beekeeping industry is in panic as a shocking number of bees die. https://www.forbes.com/sites/amyfeldman/2025/02/06/the-beekeeping-industry-is-in-panic-as-a-shocking-number-of-bees-die/
Frank EG. and A. Sudarshan. 2024. The Social Costs of Keystone Species Collapse: Evidence from the Decline of Vultures in India. *American Economic Review* 114 (10): 3007–40.
Gad, M., V. Nikolaev, A. Tahoun, and L. van Lent. 2024. Firm-level political risk and credit markets. *Journal of Accounting & Economics* 77 (2-3):101642.
Garel, A., A. Romec, Z. Sautner, and A. F. Wagner. 2024. Do investors care about biodiversity? *Review of Finance* 28 (4):1151-1186.
Giglio, S., T. Kuchler, J. Stroebel, and X. Zeng. 2023. Biodiversity risk. *NBER Working Paper https://www.nber.org/papers/w31137*.
Ginglinger, E., and Q. Moreau. 2023. Climate risk and capital structure. *Management Science* 69 (12):7492-7516.
Hartzmark, S. M., and A. B. Sussman. 2019. Do investors value sustainability? A natural experiment examining ranking and fund flows. *The Journal of Finance* 74 (6):2789-2837.
Heal, G. 2004. Economics of biodiversity: an introduction: *Elsevier, 105-114*.
Hong, H., G. A. Karolyi, and J. A. Scheinkman. 2020. Climate finance. *The Review of Financial Studies* 33 (3):1011-1023.
Houston, J. F., and H. Shan. 2022. Corporate ESG profiles and banking relationships. *The Review of Financial Studies* 35 (7):3373-3417.
Huang, H. H., J. Kerstein, C. Wang, and F. Wu. 2022. Firm climate risk, risk management, and bank loan financing. *Strategic Management Journal* 43 (13):2849-2880.
Huang, S., S. Roychowdhury, and E. Sletten. 2020. Does litigation deter or encourage real earnings management? *The Accounting Review* 95 (3):251-278.
Ilhan, E., P. Krueger, Z. Sautner, and L. T. Starks. 2023. Climate risk disclosure and institutional investors. *The Review of Financial Studies* 36 (7):2617-2650.
Ivanov, I. T., M. S. Kruttli, and S. W. Watugala. 2024. Banking on carbon: Corporate lending and cap-and-trade policy. *The Review of Financial Studies* 37 (5):1640-1684.
Ivashina, V. 2009. Asymmetric information effects on loan spreads. *Journal of Financial Economics* 92 (2):300-319.
Kang, Y., O. Z. Li, and Y. Lin. 2021. Tax incidence in loan pricing. *Journal of Accounting & Economics* 72 (1):101418.
Karolyi, G. A., and J. Tobin‐de la Puente. 2023. Biodiversity finance: A call for research into financing nature. *Financial Management* 52 (2):231-251.
Kim, T., and Q. Xu. 2022. Financial constraints and corporate environmental policies. *The Review of Financial Studies* 35 (2):576-635.
Kogan, L., D. Papanikolaou, A. Seru, and N. Stoffman. 2017. Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics* 132 (2):665-712.
Krüger, P. 2015. Corporate goodness and shareholder wealth. *Journal of Financial Economics* 115 (2):304-329.
Levy, H., R. Shalev, and E. Zur. 2018. The effect of CFO personal litigation risk on firms' disclosure and accounting choices. *Contemporary Accounting Research* 35 (1):434-463.
Liang, H., L. Sun, and M. Teo. 2022. Responsible hedge funds. *Review of Finance* 26 (6):1585-1633.
Lin, C., Y. Ma, P. Malatesta, and Y. Xuan. 2012. Corporate ownership structure and bank loan syndicate structure. *Journal of Financial Economics* 104 (1):1-22.

Martini, F., Z. Sautner, S. Steffen, and C. Theunisz. 2024. Climate transition risks of banks. *Swiss Finance Institute Research Paper* (23-66).
OECD. 2020. Comprehensive overview of global biodiversity finance.
———. 2021. Biodiversity, natural capital and the economy: A policy guide for finance, economic and environment ministers
Pan, Y., T. Y. Wang, and M. S. Weisbach. 2018. How management risk affects corporate debt. *The Review of Financial Studies* 31 (9):3491-3531.
Pástor, Ľ., R. F. Stambaugh, and L. A. Taylor. 2021. Sustainable investing in equilibrium. *Journal of Financial Economics* 142 (2):550-571.
———. 2022. Dissecting green returns. *Journal of Financial Economics* 146 (2):403-424.
Raynor, J. L., C. A. Grainger, and D. P. Parker. 2021. Wolves make roadways safer, generating large economic returns to predator conservation. The Proceedings of the National Academy of Sciences (PNAS) Jun 1;118 (22): e2023251118
Reghezza, A., Y. Altunbas, D. Marques-Ibanez, C. R. d'Acri, and M. Spaggiari. 2022. Do banks fuel climate change? *Journal of Financial Stability* 62:101049.
Rodríguez-Garavito, C., and D. R. Boyd. 2023. A rights turn in biodiversity litigation? *Transnational Environmental Law* 12 (3):498-536.
Roncoroni, A., S. Battiston, L. O. Escobar-Farfán, and S. Martinez-Jaramillo. 2021. Climate risk and financial stability in the network of banks and investment funds. *Journal of financial stability* 54:100870.
Sautner, Z., L. Van Lent, G. Vilkov, and R. Zhang. 2023. Firm-level climate change exposure. *The Journal of Finance* 78 (3):1449-1498.
Sautner, Z., J. Yu, R. Zhong, and X. Zhou. 2024. The EU taxonomy and the syndicated loan market. *Available at SSRN 4058961*.
WEF 2023. Global risks report 2023.
Zhou, B., and H. Ding. 2023. How public attention drives corporate environmental protection: Effects and channels. *Technological Forecasting & Social Change* 191:122486.

Figure 1. The percentage of biodiversity risk across years

The figure shows the percentage of firms mentioning biodiversity risk in 10-K reports across years. The X-axis is the years from 2004 to 2019. The Y-axis is the percentage of biodiversity risk (pct_biocount), which is the number of firms with biodiversity risk divided by the number of firms in year t. The red line is the fitted value of the data points.

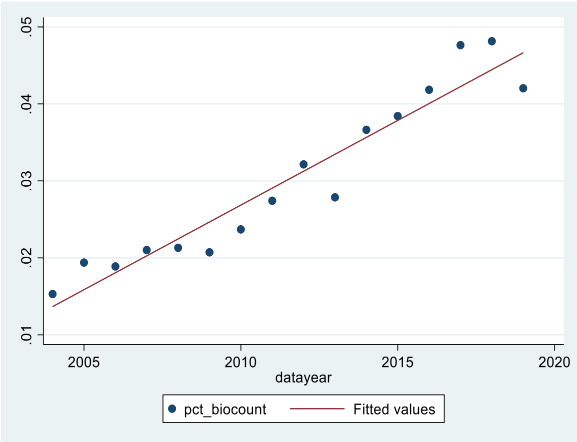

Table 1. Summary statistics

This table shows the summary statistics of the key variables. The sample structure is at the tranche-bank level with 21,497 observations. *Spread* is calculated as a coupon spread over LIBOR on the drawn amount plus the annual fee ("all-in-spread drawn" in DealScan Database divided by 100). *BIO_RISK* is a dummy variable, which equals one if the firm disclosed biodiversity-related words in the 10-K reports; zero otherwise. All the other variables are defined in Appendix A. All the continuous variables are winsorized at the 1% and 99%.

	Mean	St.Dev	p25	Median	p75
Spread (in 100bps)	1.991	1.474	0.950	1.500	2.500
LOG_MATURITY	3.876	0.609	3.611	4.111	4.111
LOG_LOAN_AMOUNT	5.449	1.509	4.422	5.461	6.553
COLLATERAL	0.406	0.491	0.000	0.000	1.000
FIN_COV	0.360	0.480	0.000	0.000	1.000
LOAN_PURPOSE	0.149	0.356	0.000	0.000	0.000
BIO_RISK	0.061	0.239	0.000	0.000	0.000
BIO_REG_RISK	0.040	0.196	0.000	0.000	0.000
BIO_PHY_RISK	0.021	0.143	0.000	0.000	0.000
Ln_MV	8.068	1.757	6.539	8.178	9.391
LEV	0.226	0.158	0.120	0.217	0.312
PPE	0.284	0.239	0.099	0.201	0.436
ROA	0.013	0.020	0.005	0.011	0.021
MTB	3.076	3.817	1.374	2.104	3.478
RET_VOLL	0.091	0.046	0.058	0.081	0.111
O_SCORE	−0.076	1.509	−0.898	0.024	0.852

Table 2. Correlation between biodiversity risk and climate change/environmental risk

The table shows the Pearson correlation between biodiversity risk and other climate change and environmental risk measures at the firm-year level. Climate change-related risk measures are from Sautner et al. (2019). Environmental risk is from the RepRisk database. All the other variables are defined in Appendix A. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Variables	(1)	(2)	(3)	(4)	(5)
(1) BIO_RISK	1.000				
(2) BIO_REG_RISK	0.815***	0.815***			
(3) BIO_PHY_RISK	0.568***	0.568***	0.568***		
(4) CC_RISK	0.025***	0.025***	0.025***	0.025***	
(7) ENV_RISK	0.150***	0.150***	0.150***	0.150***	0.150***

Table 3. Biodiversity risk and loan spread

This table shows the OLS regression of loan spread on firm-level biodiversity disclosure. The dependent variable is the loan tranche spread calculated as coupon spread over LIBOR on the drawn amount plus the annual fee ("all-in-spread drawn" in DealScan Database divided by 100). The variable of interest is the dummy variable *BIO_RISK*, which equals one if the firm disclosed biodiversity-related words in the 10-K reports; zero otherwise. Control variables include loan characteristics and borrower characteristics. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*Spread*			
	(1)	(2)	(3)	(4)
BIO_RISK	0.496***	0.484***	0.513***	0.303*
	(3.209)	(3.652)	(4.299)	(1.753)
LOG_MATURITY	0.052	0.082	0.103*	0.090
	(0.828)	(1.543)	(1.952)	(1.498)
LOG_LOAN_AMOUNT	−0.163***	−0.167***	−0.140***	−0.131***
	(−4.292)	(−4.643)	(−4.749)	(−4.262)
COLLATERAL	0.380***	0.354***	0.321***	0.249**
	(3.538)	(3.273)	(3.059)	(2.041)
FIN_COV	−0.528***	−0.407***	−0.329***	−0.328***
	(−5.424)	(−4.415)	(−3.536)	(−3.277)
LOAN_PURPOSE	0.388**	0.312**	0.301**	0.167
	(2.379)	(2.263)	(2.097)	(0.976)
Ln_MV	0.157*	0.134	0.115	0.072
	(1.655)	(1.633)	(1.593)	(0.865)
LEV	0.150	0.180	0.210	0.275
	(0.398)	(0.507)	(0.715)	(0.724)
PPE	−1.026	−0.978	−1.271*	−0.426
	(−1.362)	(−1.388)	(−1.883)	(−0.533)
ROA	0.010	−0.567	0.153	−0.064
	(0.005)	(−0.321)	(0.099)	(−0.035)
MTB	−0.014	−0.017*	−0.016**	−0.015
	(−1.595)	(−1.781)	(−2.168)	(−1.293)
RET_VOL	0.090*	0.097**	0.091**	0.061
	(1.903)	(2.267)	(2.349)	(1.310)
O_SCORE	0.496***	0.484***	0.513***	0.303*
	(3.209)	(3.652)	(4.299)	(1.753)
Borrower FE	Yes	Yes	Yes	No
Loan Type FE	No	Yes	Yes	Yes
Year FE	Yes	Yes	No	Yes
Lender FE	No	Yes	No	No
Lender × Year FE	No	No	Yes	No
Lender × Borrower FE	No	No	No	Yes
Obs.	21,497	21,216	20,645	19,400
Adj. R^2	0.730	0.766	0.783	0.793

Table 4. Mechanism tests: Nuanced role of banks

This table shows the mechanism tests on regulatory risk vs.. physical risk and banks' heterogeneous influence on the two risks. In Column (1), *BIO_REG_RISK* equals 1 if the firm's biodiversity risk is regulatory risk, 0 otherwise. *BIO_PHY_RISK* equals one if the firm's biodiversity risk is physical risk, zero otherwise. In Column (2), *TOPBIO_FINANCER* is the number of lead/co-lead arrangers that belong to the top 10 banks for biodiversity financing. In Column (3), *RELA_LENDING* is a dummy variable that equals one if the bank was ever the lead arranger for the borrower within the last 5 years; zero otherwise. Control variables include loan characteristics and borrower characteristics. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =		*Spread*	
	(1)	(2)	(3)
BIO_REG_RISK	0.410***	0.248	0.434***
	(2.698)	(1.549)	(2.724)
BIO_PHY_RISK	0.687***	1.656***	0.730***
	(3.516)	(4.033)	(3.932)
Equality Test	P=0.2723		
BIO_REG_RISK × SIN_BANKS		0.208***	
		(4.062)	
BIO_PHY_RISK × SIN_BANKS		−0.926***	
		(−3.723)	
Equality Test		P=0.0000	
BIO_REG_RISK × RELA_LENDING			−0.088
			(−1.076)
BIO_PHY_RISK × RELA_LENDING			−0.494***
			(−4.377)
Equality Test			P=0.0005
SIN_BANKS		−0.066*	
		(−1.809)	
RELA_LENDING			−0.002
			(−0.036)
Controls	Yes	Yes	Yes
Borrower FE	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes
Obs.	21,216	21,216	21,216
Adj. R^2	0.767	0.770	0.767

Table 5. Identification: Biodiversity lawsuit

The table shows the effect of state-level biodiversity lawsuits on the bank loan spread. In Panel A, *BIO_LAWSUIT* equals one if the borrower's headquarters is located in the state that is affected by the biodiversity lawsuits after the initiation of the lawsuit; zero otherwise. In Panel B, we conduct dynamic analysis to examine the pre-trend of the staggered DID design. We use the dummy variable of biodiversity lawsuit before and after the event. For example, *BIO_LAWSUIT (t−1)* is the indicator that equals one if it is the one year before the firm's headquarter state involving in a biodiversity lawsuit. Control variables include loan characteristics and borrower characteristics. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Panel A. Biodiversity lawsuit and loan spread

Dependent Variable =	*Spread*
	(1)
BIO_LAWSUIT	−0.452**
	(−2.011)
Controls	Yes
Borrower FE	Yes
Loan Type FE	Yes
Year FE	Yes
Lender FE	Yes
Obs.	21,216
Adj. R^2	0.766

Panel B. Dynamic analysis

Dependent Variable =	*Spread*
	(1)
BIO_LAWSUIT (<=t−3)	−0.166
	(−0.429)
BIO_LAWSUIT (t−2)	0.411
	(0.827)
BIO_LAWSUIT (t−1)	0.533
	(1.170)
BIO_LAWSUIT (t)	−0.707**
	(−2.189)
BIO_LAWSUIT (t+1)	−0.358
	(−0.913)
BIO_LAWSUIT (t+2)	−0.386*
	(−1.679)
Controls	Yes
Borrower FE	Yes
Loan Type FE	Yes
Year FE	Yes
Lender FE	Yes
Obs.	21,216
Adj. R^2	0.768

Table 6. Additional controls of climate change risk and environmental risk

This table shows the robustness test after controlling for climate change risk and other environmental risk measures. *CC_RISK* is the climate change risk measure used by Sautner et al. (2019) based on climate change content disclosed in a conference call. *ENV_RISK* is the risk measure offered by the RepRisk database multiplied by the percentage of environmental-related issues. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*Spread*	
	(1)	(2)
BIO_RISK	0.505***	0.470**
	(3.528)	(2.063)
CC_RISK	0.092	0.306***
	(1.129)	(2.782)
ENV_RISK		0.013
		(1.015)
Controls	Yes	Yes
Borrower FE	Yes	Yes
Loan Type FE	Yes	Yes
Year FE	Yes	Yes
Lender FE	Yes	Yes
Obs.	21,216	12,230
Adj. R^2	0.766	0.770

Table 7. Government support for the Victims

This table presents the relationship between corporate tax liabilities and biodiversity risk, with a particular focus on tax-related government support for firms affected by physical risk (i.e., the "Victims"). Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*Tax Payable*	
	(1)	(2)
BIO_RISK	−0.002	
	(−0.568)	
BIO_REG_RISK		0.001
		(0.469)
BIO_PHY_RISK		−0.006**
		(−2.473)
Equality Test		P=0.038
Controls	Yes	Yes
Borrower FE	Yes	Yes
Loan Type FE	Yes	Yes
Year FE	Yes	Yes
Lender FE	Yes	Yes
Obs.	20,326	20,326
Adj. R^2	0.809	0.810

Table 8. Interest expense

Panel A. Biodiversity risk and interest expense

Dependent Variable =	*Interest Expense*	
	(1)	(2)
BIO_ RISK	0.001**	
	(2.347)	
BIO_REG_RISK		0.002**
		(2.527)
BIO_PHY_RISK		0.000
		(0.559)
Equality Test		P=0.1247
Ln_MV	−0.002***	−0.002***
	(−11.331)	(−11.306)
LEV	0.035***	0.035***
	(33.116)	(33.112)
PPE	−0.004***	−0.004**
	(−2.589)	(−2.557)
ROA	−0.002**	−0.002*
	(−1.974)	(−1.937)
MTB	0.000	0.000
	(0.465)	(0.468)
O_SCORE	0.000***	0.000***
	(3.542)	(3.585)
RET_VOL	0.014***	0.014***
	(6.798)	(6.806)
Firm & Year FE	Yes	Yes
Obs.	26,390	26,390
Adj. R^2	0.770	0.770

Panel B. Comparison between biodiversity risk and climate risk

Dependent Variable =	*Interest Expense*	
	(1)	(2)
BIO_ RISK	0.001**	
	(2.345)	
CC_RISK	−0.000	
	(−0.463)	
Equality Test	P=0.0167	
BIO_REG_RISK		0.002**
		(2.537)
CC_*REG_RISK*		0.000
		(0.537)
Equality Test		P=0.0204
BIO_PHY_RISK		−0.000
		(−0.157)
CC_*PHY_RISK*		0.001
		(1.369)
Equality Test		P=0.7846
Control	Yes	Yes
Firm & Year	Yes	Yes
Obs.	26,390	26,390
Adj. R^2	0.770	0.770

Table 9. Robustness tests

This table shows two robustness tests for the OLS regression in Table 3. For Panel A, we replace the *Spread* with the *Net Spread* calculated as the spread minus the up-front fee, following Ivashina (2009). In Panel B, we aggregate the sample into the borrower firm-year sample structure. Loan characteristics are averaged for each firm-year observation, indicated by the suffix (*_AGV*). Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Panel A. Spread net upfront fee

Dependent Variable =	*Net Spread*			
	(1)	(2)	(3)	(4)
BIO_RISK	0.387**	0.371***	0.368***	0.219
	(2.479)	(2.773)	(3.109)	(1.327)
Controls	Yes	Yes	Yes	Yes
Borrower FE	Yes	Yes	Yes	No
Loan Type FE	No	Yes	Yes	Yes
Year FE	Yes	Yes	No	Yes
Lender FE	No	Yes	No	No
Lender × Year FE	No	No	Yes	No
Lender × Borrower FE	No	No	No	Yes
Obs.	21,497	21,216	20,645	19,400
Adj. R^2	0.716	0.751	0.770	0.775

Panel B. Firm-year sample

Dependent Variable =	*Spread_AVG*	
	(1)	(2)
BIO_RISK	0.344**	0.451**
	(2.158)	(2.493)
LOG_MATURITY_AVG		0.028
		(0.264)
LOG_LOAN_AMOUNT_AVG		−0.271***
		(−5.635)
COLLETERAL_AVG		0.401***
		(3.445)
FIN_COV_AVG		−0.601***
		(−5.383)
LOAN_PURPOSE_AVG		0.395***
		(2.694)
Ln_MV		0.015
		(0.128)
LEV		0.323
		(0.538)
PPE		−0.573
		(−0.700)
ROA		−0.269
		(−0.302)
MTB		0.009
		(0.540)
TER_VOL		−0.966
		(−0.777)
O_SCORE		0.061
		(0.742)
Borrower FE	Yes	Yes
Year FE	Yes	Yes
Obs.	1,207	1,128
Adj. R^2	0.602	0.655

Appendix A: Variable definition

Variable	Definition
BIO_RISK	A dummy variable equals one if the firm disclosed biodiversity-related words in the 10-K reports; zero otherwise. The data follows Giglio et al. (2023) from the author's website http://www.biodiversityrisk.org/download/
BIO_REG_RISK	A dummy variable equals one if the disclosed biodiversity risk is regarding regulatory risk; zero otherwise. The data follows Giglio et al. (2023) from the author's website http://www.biodiversityrisk.org/download/
BIO_PHY_RISK	A dummy variable equals one if the disclosed biodiversity risk is regarding physical risk but not regulatory risk; zero otherwise. Specifically, *BIO_PHY_RISK* equals one if *BIO_RISK* equals one but *BIO_REG_RISK* equals zero.
BIO_LAWSUIT	A dummy variable equals one if the borrower's headquarters is located in the state that is affected by the biodiversity lawsuit after the initiation of the litigation; zero otherwise.
CC_RISK	Climate change risk measure from Sautner et al. (2023). We use dummy variable that equals one if the firm mentions climate risk in their annual report; zero otherwise.
CC_REG_RISK	Dummy variable equals one if the firm mentions climate risk related to regulation risk; zero otherwise.
CC_PHY_RISK	Dummy variable equals one if the firm mentions climate risk related to physical risk; zero otherwise.
ENV_RISK	Environmental risk measured by RepRisk. Using the risk score multiply the environmental percentage.
Spread	The loan tranche spread is calculated as coupon spread over LIBOR on the drawn amount plus the annual fee ("all-in-spread drawn" in DealScan Database divided by 100).
LOG_MATURITY	Loan maturity is calculated as the logarithm of maturity (months) of each loan tranche.
LOG_LOAN_AMOUNT	Loan size is calculated as the logarithm of the loan amount (in $million) of each loan tranche.
COLLETERAL	An indicator variable that takes the value of one if a given loan tranche is collateralized, and zero otherwise.
FIN_COV	An indicator variable that takes the value of one if a given loan tranche is attached to any financial covenant, and zero otherwise.
LOAN_PURPOSE	An indicator variable that takes the value of one if the main purpose of a loan tranche belongs to one of the following: acquisition, MBO, takeover or recapitalization, and zero otherwise.
Ln_MV	Borrower's market value, calculated as the logarithm of stock price multiply the number of shares outstanding.
LEV	Borrower's leverage ratio, calculated as the long-term debt scaled by total assets.

PPE	Borrower's tangible assets are calculated as the net PPE scaled by total assets.
ROA	The borrower's ROA is calculated as the income before extraordinary items scaled by total assets.
MTB	Borrower's market-to-book ratio. Market value is calculated as the number of outstanding shares multiplied by the stock price at the end of the year (year-quarter). Book value is the book value of equity at the end of the year (year-quarter).
RET_VOL	Stock return volatility calculated as monthly stock return volatility over the past two years.
O_SCORE	Ohlson O-score, following Ohlson (1980), to measure borrowers' bankruptcy risk. A higher value of O-score represents a higher bankruptcy risk.
SIN_BANK	A number of arrangers/co-arrangers for each loan tranche that belongs to the top 10 banks that are criticized for financing sectors causing biodiversity loss.
RELA_LENDING	The dummy variable equals one if the bank was ever the lead bank for the borrower within the last 5 years; zero otherwise.
Tax Payable	Tax payable scaled by total asset.
Interest Expense	Firm's interest expense scaled by total assets.
Net Spread	Spread minus the up-front fee.
Spread_AVG	Loan spread aggregated at the firm-year level. If other loan characteristics are also averaged for each firm-year, it is also indicated by the suffix (*_AGV*)
ESG_IOR	ESG-oriented investors' ownership ratio according to the value-weighted ESG scores (from the MSCI KLD database) of their portfolio holdings, following Cao et al. (2023).
R&D_RANK	Decline ranking or R&D expenditure within the sample. Borrower's R&D is the R&D expenditure scaled by total revenue.
Ln_GreenPatent	The natural log transformation of the number of green patents (*Ln_GreenPatent*). Green patents are derived from the patent data source developed by Kogan et al. (2017) and then matched with the patent classification from the OECD. The source of the patent dataset and green patent. https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data; https://www.oecd-ilibrary.org/environment/measuring-environmental-innovation-using-patent-data_5js009kf48xw-en

Appendix B. Examples of biodiversity risk in 10-K reports

Example 1. Perpetrators: Transition risk of biodiversity loss (AES Corporation, 2019)

> Our businesses are subject to stringent environmental laws and regulations by many federal, regional, state and local authorities, international treaties and foreign governmental authorities. These laws and regulations generally concern emissions into the air, effluents into the water, use of water, wetlands preservation, remediation of contamination, waste disposal, endangered species and noise regulation. Failure to comply with such laws and regulations or to obtain or comply with any associated environmental permits could result in fines or other sanctions. For example, in recent years, the EPA has issued notices of violation (NOVs) to a number of coal-fired

Example 2. Victims: Physical risk of biodiversity loss (American Water Works Company, 2018)

> Our ability to meet the existing and future water demands of our customers depends on an adequate water supply. Drought, governmental restrictions, overuse of sources of water, the protection of threatened species or habitats, contamination, or other factors may limit the availability of ground and surface water. We employ a variety of measures in an effort to obtain adequate sources of water supply, both in the short-term and over the long-term. The geographic diversity of our service areas may mitigate some of the economic effect on the water supply associated with weather extremes we might encounter in any particular service territory. For example, in any given summer, some areas may experience drier than average weather, which may reduce the amount of source water available, while other areas we serve may experience wetter than average weather.

Appendix C: Case summary of biodiversity lawsuits

State	Petition Year	Lawsuit (s)
California	2007	*Center for Biological Diversity v. California Department of Fish and Game Commission*
	2009	*Center for Biological Diversity v. California Public Utilities Commission*
	2009	*Center for Biological Diversity v. California Department of Forestry*
	2009	*Center for Biological Diversity v. Town of Yucca Valley*
	2008	*Center for Biological Diversity v. City of Desert Hot Springs*
	2010	*Center for Biological Diversity v. California Department of Forestry and Fire Protection*
	2010	*Center for Biological Diversity v. Department of Fish and Wildlife*
North Carolina	2010	*Defenders of Wildlife v. North Carolina Department of Transportation*
Massachusetts	2017	*Conservation Law Foundation v. Department of Environmental Protection*
Arizona State	2017	*Center for Biological Diversity v. U.S. Fish & Wildlife Service (for Arizona endangered species)*

Appendix D: Validation test of biodiversity lawsuits and biodiversity risk

This table shows the results of the validation test of the impact of biodiversity lawsuits on firm-level biodiversity risk. The regression analysis is conducted at the firm-year level and adds firm and year-fixed effects. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*BIO_RISK*
	(1)
BIO_LAWSUIT	−0.013**
	(−2.459)
Ln_MV	−0.000
	(−0.230)
LEV	−0.007
	(−0.682)
PPE	0.005
	(0.208)
ROA	−0.030***
	(−2.810)
MTB	−0.000
	(−0.528)
R&D	−0.035**
	(−2.408)
Firm & Year FE	Yes
Obs.	39,376
Adj. R^2	0.555

Appendix E. Borrower characteristics: Green governance and innovation

This table shows the cross-sectional tests based on borrower characteristics. Column (1) shows the effect of green governance proxied by ESG-oriented Investors. *ESG_IOR* is the institutional ownership ratio of borrowers based on the value-weighted ESG scores of their portfolio holdings. Column (2) shows the effect of R&D decile rankings. Control variables include loan characteristics and borrower characteristics. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*Spread*	
	(1)	(2)
BIO_RISK	0.672***	0.798***
	(4.211)	(4.347)
ESG_IOR	−0.111	
	(−0.146)	
BIO_RISK × ESG_IOR	−9.884***	
	(−4.381)	
R&D_RANK		−0.005
		(−0.283)
BIO_RISK × R&D_RANK		−0.159***
		(−3.440)
Borrower FE	Yes	Yes
Loan Type FE	Yes	Yes
Year FE	Yes	Yes
Lender FE	Yes	Yes
Obs.	22,093	22,093
Adj. R^2	0.775	0.766

Appendix F: Consequence on green innovation output

This table represents the consequence test on firms' green innovation output. The dependent variable is the natural logarithm of the number of green patents filed by the firm (*Ln_GreenPatent*). For comparability, we restrict the test to the firms that have at least one patent filed. Standard errors are clustered at the firm level, and the corresponding *t*-statistics are included in parentheses. Levels of significance are presented as follows: *p<0.1; **p<0.05; ***p<0.01.

Dependent Variable =	*Ln_GreenPatent*
	(1)
BIO_RISK × Spread_AVG	−0.325***
	(−3.565)
BIO_RISK	0.470
	(0.843)
Spread_AVG	0.006
	(0.114)
Ln_MV	−0.037
	(−0.272)
LEV	−0.999*
	(−1.835)
PPE	−0.457
	(−0.304)
ROA	−1.982*
	(−1.698)
MTB	0.019**
	(2.124)
R&D	−7.024*
	(−1.778)
Firm & Year FE	Yes
Obs.	362
Adj. R^2	0.812