

Biodiversity Risk

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Recent developments in finance research

Recent interest in understanding and managing the complex relationships between the [economy](#) and the [health of our planet](#).

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Climate Finance:

- ▶ How does climate change affect economic activity and asset values?
- ▶ What role can financial markets play to accelerate the "green transition"?
- ▶ Active literature (reviewed in Giglio, Kelly and Stroebe (2021))

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Biodiversity Loss: Similarly important but understudied (Karolyi, Tobin-delaPueente 2023)

This Paper:

- ▶ Do people (in finance) worry about biodiversity risk?
- ▶ Measure biodiversity risks over time and across firms and industries.
- ▶ Is biodiversity risk priced in financial markets?
- ▶ Construct and release new data to facilitate research on biodiversity risks (www.biodiversityrisk.org)

What is Biodiversity Risk? Physical vs. Transition

Biodiversity: the sum total of genes, species, and ecosystems

- ▶ Losses of ecosystem services estimated to cause damages of \$4trn-\$20trn per year

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Physical Biodiversity Risks from the loss of biodiversity and ecosystem services

- ▶ Deforestation or habitat loss → raw material and supply chain of paper product firms
- ▶ Species or genetic biodiversity loss → R&D of pharma and biotech sectors, food production
- ▶ Biodiversity loss → disruption of ecosystem, increased vulnerability to climate change

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Transition Biodiversity Risks from responses to reduce biodiversity loss

- ▶ Regulation: land-use regulations, sustainable forestry requirements, or species protection laws
- ▶ Consumer preference: shifts away from palm oil due to its effect on deforestation
- ▶ Reputation: increased cost of causing ecological disasters such as oil spills

Overview

- ▶ Do people worry about biodiversity risk?
- ▶ Is biodiversity risk priced in equity markets?
 - ▶ Measuring aggregate biodiversity risk
 - ▶ Risk exposure by firms/ sectors
 - ▶ Pricing in equity markets

Do People Worry About Biodiversity Risk?

Objective: How do researchers and market participants think about biodiversity risks?

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→ A survey of the perceptions of biodiversity risks among finance academics, professionals, public sector regulators, and policy economists (668 responses).

Do People Worry About Biodiversity Risk?

Biodiversity risks for investors and firms are often divided into (i) physical risks coming from actual changes in biodiversity (e.g., reduced pollinators, freshwater scarcity) and (ii) transition risks coming from changes in the regulatory environment to combat biodiversity loss (e.g., the Clean Water Act). Please rate the financial materiality of these risks for corporations in the United States.

	Not at all important	Slightly important	Moderately important	Very important
Physical Biodiversity Risks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Transition Biodiversity Risks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Do People Worry About Biodiversity Risk?

- ▶ Around 70% of respondents perceive physical and transition biodiversity risks to have **at least moderate financial materiality** for firms in the United States
- ▶ **Private sector** respondents report highest perceived financial materiality of risks.
- ▶ About 20% of respondents believe that physical and transition biodiversity risks **are already materializing today**
- ▶ Transition risks perceived as somewhat more important over the **next five years**.

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- ▶ **Traditional Approach:** Higher expected returns for long-short portfolios based on risk exposures (controlling for other risks)?
 - ▶ Proxy for expected returns with realized returns → Problematic over short horizons
 - ▶ Prices ↓ when risk first becomes prized → Realized returns lower

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- ▶ **Our approach:** Do long-short portfolio returns co-move with news about future damages arising from the biodiversity risk?
 - ▶ Bad news about biodiversity → Price ↓ for exposed stocks
 - ▶ Good news about biodiversity → Price ↑ for exposed stocks
 - Easier to estimate covariances than means in short-ish time series

Are Biodiversity Risks Priced in Equity Markets?

- ▶ Do long-short portfolio returns co-move with news about future damages arising from the biodiversity risk?
- ▶ Need
 - ▶ Higher-frequency measure of **news** about future damages from biodiversity risk
 - ▶ Measures of exposure to biodiversity risk by firms / sectors to form portfolios

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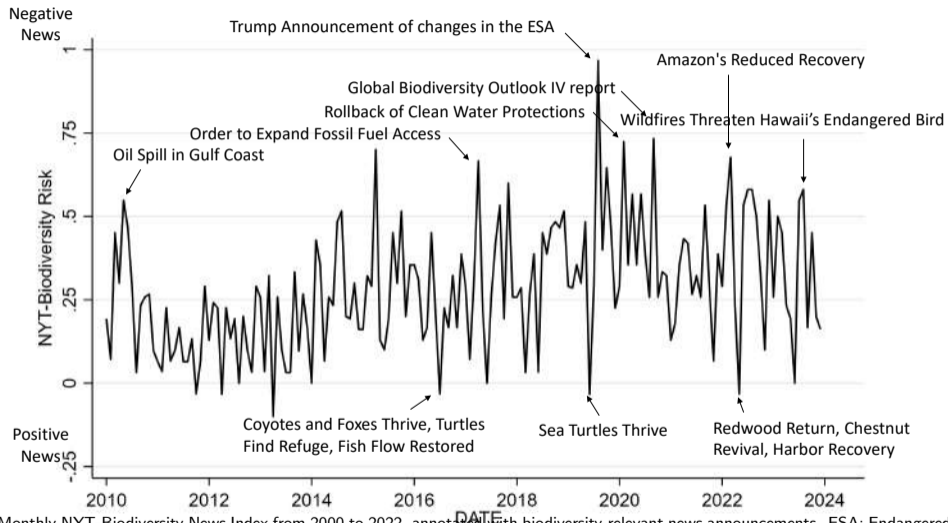
NYT Biodiversity News Index:

- ▶ Use a **dictionary-based approach** to identify NYT articles that cover biodiversity risk (terms include “ecosystem”, “deforestation”, “habitat”, etc.)
- ▶ Article sentiment: Bidirectional Encoder Representations from Transformers (**BERT**)
- ▶ Index: Number of negative biodiversity articles minus the number of positive biodiversity articles.

Google Biodiversity Attention Index:

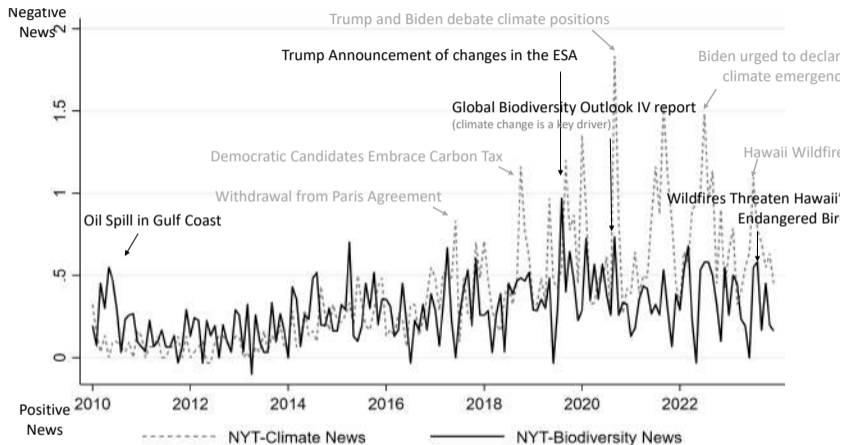
- ▶ Google search activity for terms like “biodiversity loss” and “species loss”
- ▶ The index is constructed as the sum of the search index series for each term

NYT-Biodiversity News Index



Note: Monthly NYT-Biodiversity News Index from 2000 to 2022, annotated with biodiversity-relevant news announcements. ESA: Endangered Species Act; IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; IPCC: Intergovernmental Panel on Climate Change.

NYT-Biodiversity News vs. NYT-Climate News



- **Biodiversity-related events** (e.g., Trump's Announcement of changes in the ESA, Oil Spill in the Gulf Coast) did not result in spikes in the climate index.

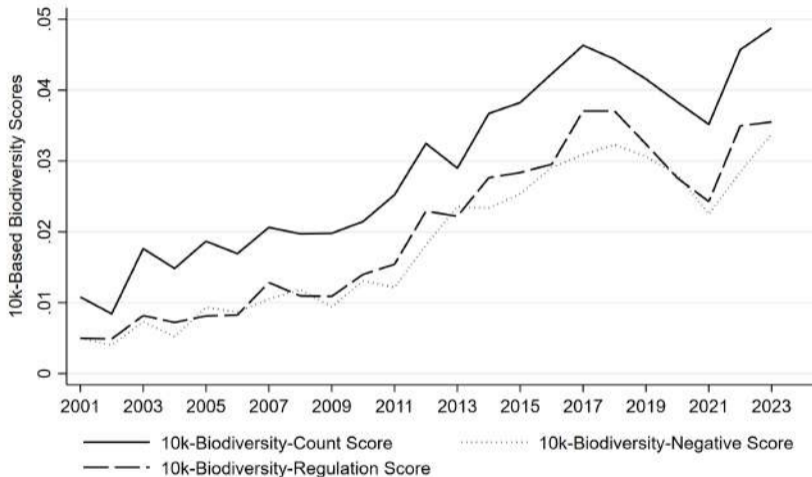
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Measures of Biodiversity Risk Exposures

- ▶ Different sectors vary in their dependence on natural capital (**physical risk**) and their effects on the environment (**regulation risk**)
- ▶ The absence of standardized disclosure frameworks for biodiversity risks makes **quantifying these exposures** hard.
- ▶ We propose several ways to measure firms' and industries' biodiversity exposures:
 - ▶ Firms' 10-K statements: textual analysis
 - ▶ Expert Survey
 - ▶ Portfolio holdings of biodiversity funds

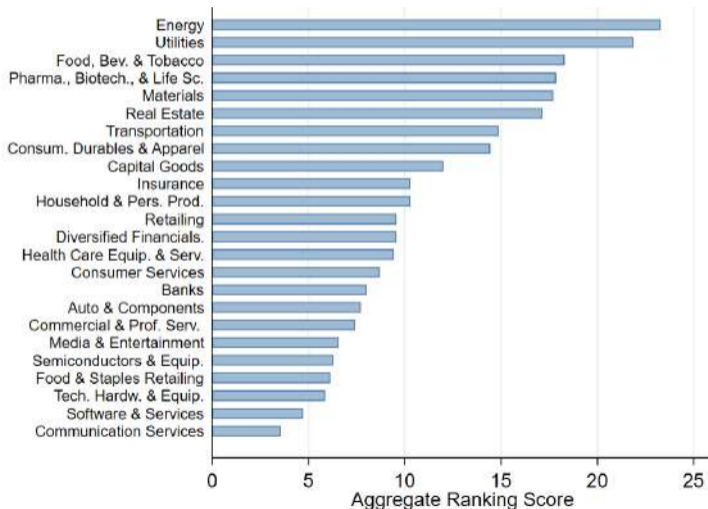
Biodiversity Risk Exposures Over Time



Self-reported biodiversity risk exposures have been growing over time.

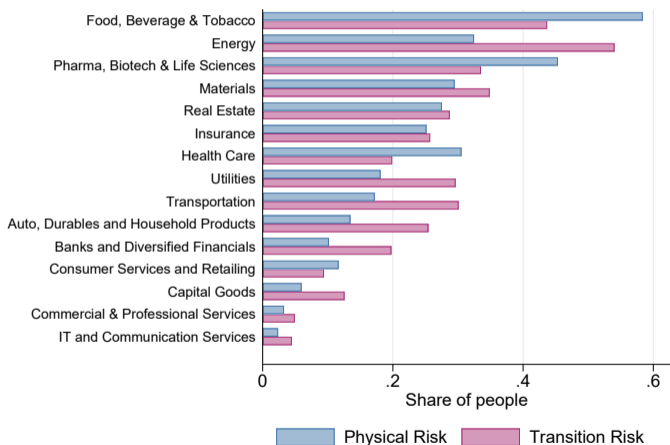
Biodiversity Risk Exposures Across Industries

- ▶ Sectors with the highest biodiversity risk exposures include **energy, utilities, and real estate**
- ▶ **Semiconductor, software, and communication services** sectors have minimal exposures.



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Variation Across Industries

Energy Sector

- ▶ Reputational and legal risks: drilling activities → oil spills & habitat destruction
- ▶ Regulatory risk: environmental regulations to prevent further biodiversity loss

“If one of our LNG terminals or pipelines may adversely affect a protected species or its habitat, we may be required to develop and follow a plan to avoid those impacts” (Cheniere Energy)

Utilities Sector

- ▶ Physical Risk: degradation of watersheds → water utility operations
- ▶ Regulatory Risk: regulations on species and habitat protection → limit utility firms' operations
- ▶ Regulatory Risk: regulations on waste discharges → elevate utility firms' costs

“The Company is also subject to laws regarding the protection of wildlife, including migratory birds, eagles, threatened and endangered species. Federal and state environmental laws have historically become more stringent over time, although this trend could change in the future” (Clearway Energy)

Variation Across Industries

Pharma and Biotech. Sector

- ▶ Physical Risk: reduced potential pharmaceutical development options

“We focus on the use of biodiversity as a means of natural product drug discovery, while also using traditional chemical discovery and development techniques” (Cubist Pharmaceuticals Inc.)

Capital Goods Sector

- ▶ Building materials: the availability of wood and other raw material, shift of consumer preference
- ▶ Distributors: the use of chemical refrigerants
- ▶ Industrial and construction: environmental protection and waste disposal regulations

“As another example, many consumers demand certified sustainably harvested wood products as concerns about deforestation have become more prevalent” (Jeld-Wen Holding Inc.)

Climate Risk Exposures vs. Biodiversity Risk Exposures

Biodiversity risk exposures are distinct from climate risk exposures.

- ▶ An industry may be highly exposed to biodiversity risk because its operations are dependent on particular ecosystems or species that are not necessarily affected by climate change
- ▶ From a regulatory perspective, some industries might have a more significant direct impact on ecosystems and habitats rather than contributing to climate change

Example: Renewable Energy

- ▶ Windfarms and birds
- ▶ Hydropower and fish
- ▶ Land use requirements for solar
- ▶ Offshore winds and whale death

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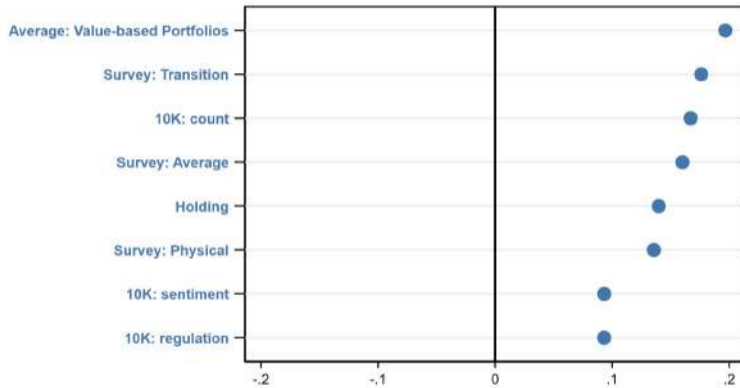
- ▶ We form equity portfolios of industries sorted by their biodiversity risk exposures
- ▶ The portfolios hold **long positions** in industries with **low biodiversity risk exposures** and short positions in industries with high biodiversity risk exposures
- ▶ If biodiversity risk is priced, the return of these biodiversity-risk-sorted portfolios should covary with the aggregate biodiversity news
 - ▶ Behave like a **hedging portfolio**
- ▶ We compare the hedge performance of our biodiversity risk measures with that of hedge portfolios constructed using other firm characteristics

Pricing of Biodiversity Risk in Equity Markets

- ▶ Want: Compare returns to news about biodiversity
- ▶ Need: Measure news in the NYT-Biodiversity News Index
- ▶ Use: Residuals from AR(1) model fitted to the NYT-Biodiversity News Index

Biodiversity Hedge Performance

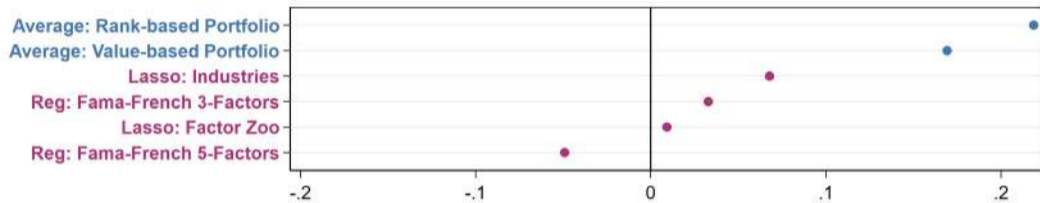
Do biodiversity portfolios hedge biodiversity news?



- ▶ All the correlations are **positive**, with magnitudes from around 0.1-0.2.
- ▶ Observed correlations are comparable to those obtained by climate hedging portfolios when evaluated against aggregate climate news

Biodiversity Hedge Performance of Portfolios Based on Other Characteristics

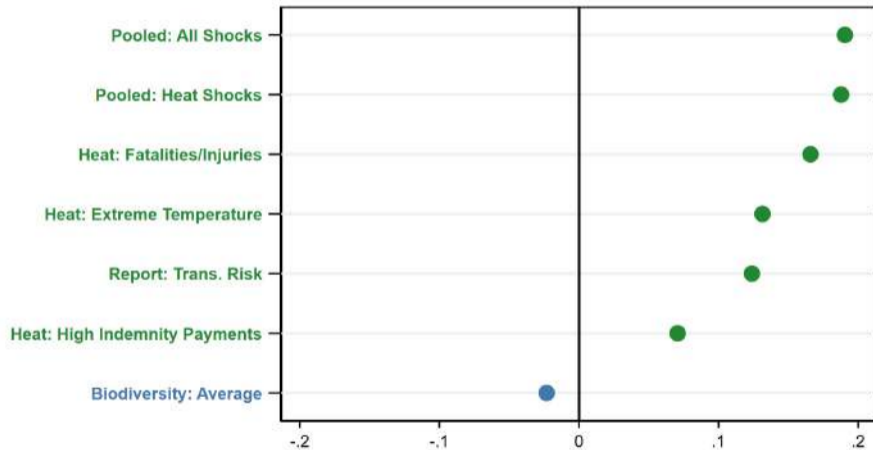
Is biodiversity exposure recasting exposure to other firm characteristics?



The portfolio built on the average biodiversity exposure measure has the highest correlation with innovations in the NYT-Biodiversity Risk Index.

Hedging Biodiversity Risk vs. Climate Risk

Do biodiversity portfolios also hedge climate change?



Portfolios designed to hedge climate risks perform better than biodiversity hedge portfolios. Biodiversity hedge portfolio has, on average, zero correlation with climate

Pricing of Biodiversity Risk in Equity Markets

- ▶ Biodiversity risk exposures vary substantially across firms and industries
- ▶ Variation is economically sensible
- ▶ Long-short portfolios on this characteristic covary with aggregate realizations of biodiversity risk → Risks are being priced

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- ▶ Long-short portfolios on this characteristic covary with aggregate realizations of biodiversity risk → Risks are being priced
- ▶ Are they priced **adequately**?
 - ▶ Very hard to say, needs measure and model of “correct” pricing
 - ▶ Survey respondents on pricing in stock market

	Role				Location				Biodiversity Concern			
	Pooled	Academic Institution	Private Sector	Public Sector	North America	Europe	Asia	ROW	Very High	High	Low	No Concern
Stock Market (%)												
Not enough	48	43	53	61	45	53	60	69	71	53	30	6
Correct	17	23	11	15	18	17	13	23	11	26	33	23
Too much	3	3	5	3	5	1	2	0	2	2	8	29
No opinion	32	31	32	21	33	28	25	9	16	19	29	42

Conclusion

- ▶ Biodiversity risks considered material by financial experts
- ▶ Introduce measures of aggregate biodiversity risk as well as measures of firms' / industries' exposures to biodiversity risks
- ▶ Show the pricing of biodiversity risks in financial markets
- ▶ Release biodiversity risk exposure measures at www.biodiversityrisk.org to facilitate more research on this important topic.