

# Biodiversity risk and bank lending

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# What is the motivation?

- Background: Biodiversity loss → physical risks (production loss) & transition risks (ongoing policy) for firms relying on ecosystem services → harm economic activities<sup>1</sup>
- Banks' role: capital allocation during green transition
  - Realizing these risks related to ecosystem-dependent firms
  - Adjusting loan costs for high biodiversity risk firms
  - Make commitments on biodiversity goals (in disclosures or initiatives)
- Research questions:
  - How to measure biodiversity risk exposure for firms?
  - Do banks care about borrowers' biodiversity risk exposure in lending, especially after banks made the commitments to do so?

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<sup>1</sup>NGFS (2021), "Biodiversity and financial stability: building the case for action"

# Our findings and contributions

- Findings
  - Lenders **do not** treat high biodiversity risk firms and industries differently in terms of price and non-price terms
  - Banks **do not** make adjustments on these loan terms after their commitments on biodiversity, compared to non-committed banks
- Contributions
  - Fitting into literature of (1) biodiversity finance and risk measurement (e.g., Giglio et al. 2023, Flammer et al. 2023, etc.), and (2) bank lending and environmental considerations
  - Constructing firm/industry level **biodiversity risk measures** based on Q&A of earnings call
  - First study to examine the effect of firms' biodiversity risk exposure on **loan quantity and costs** using a global sample of lenders and borrowers
  - Policy implications: the limitation of **banks' voluntary commitment on biodiversity**

# Data overview: Sources and matching

- Main data sources
  - Earnings call transcripts: **Refinitiv** AdvEvents
  - Syndicated loans: **DealScan**
  - Bank-level commitment on biodiversity: BEI, FfB, PBAF, and Forest500
  - Financial data for borrowers: Refinitiv, Compustat
  - Financial data for lenders: Compustat, Refinitiv, BankFocus, Call Report
- Data matching:
  - Old DealScan to Worldscope: Link table of Beyhaghi et al. (2021)
  - Old DealScan to new DealScan: WRDS mapping
  - Compustat to DealScan (lender): Chava and Roberts (2008)
  - Compustat to DealScan (borrower): Schwert (2018)
  - Unmatched borrowers and lenders: algorithm based on Google Search Engine

# Data overview: Sample coverage

- Sample coverage:
  - Sample period: 2010 to 2022
  - Data level: **one main lead arranger (e.g., admin agent) - deal - one largest-earliest tranche level** (for the main tests), with loans of 715 global banks to 3,250 borrowers
- Country distribution
  - Lenders' country distribution: 244 banks (34.1%) have parent operating country in the US, 188 (26.3%) in the EU, 31 (4.3%) in Japan, and 252 (35.2%) elsewhere
  - Borrowers' country distribution: 2,102 firms (64.6%) have headquarters located in the US, 460 (14.1%) in the EU, 141 (4.3%) in the UK, and 547 (16.8%) elsewhere

# Text-based measurement: Earnings call based measures

- Reasons for us to use the Q&A section of earnings call
  - Flexible and investor-related, with discussion less scripted
  - Timeliness and informativeness, at quarterly frequency
- Procedure
  - *Step 1*: Bag of words searching for biodiversity-related sentences (Giglio et al. 2023)
  - *Step 2*: BERT sentiment classification for biodiversity-related sentences
  - *Step 3*: Calculating biodiversity risk measures (e.g., percentage/frequency measures, negative/positive measures, *Negative Score*, industry-level measures)
- Challenges
  - *Challenge 1*: Words are mentioned in irrelevant contexts → dependency parsing & condition of counting
  - *Challenge 2*: Noise from spurious mention: aggregating into industry (NAICS) level

# Text-based measurement: Description and distribution

- Percentage of firms' mention of biodiversity-related terms
  - *Observation:* the measures reflect firm's production dependency on ecosystem
  - Q&A section: 3% mentioned at least once, 1.2% at least twice
  - Presentation section: 4.5%: mentioned at least once, 1.9% at least twice
- Consistency of mention
  - If a firm mentioned in Q&A, the firm has: 32% chance to mention again in the next Q&A, 53.9% in any of the consecutive four Q&As
  - If a firm mentioned any biodiversity term in Presentation, the firm has: 46% chance to mention again in the next Presentation, 64% in any of the consecutive four Presentations
- Sentiment
  - *Observation:* the measures reflect the condition of firm's ecosystem-related business
  - Q&A: 10.6% are negative, 27.5% are positive, and 61.9% are neutral
  - Presentation: 13.1% are negative, 56% are positive, and 30.9% are neutral

## Text-based measurement: Word frequency

- Q&A section: terms with top five highest frequency are “marine” (9,550), “forest(ry)” (8,357), “flora” (537), “tropical” (474), and “ecosystem” (426)
- Presentation section: terms with top five highest frequency are “marine” (14,743), “forest(ry)” (10,942), “tropical” (944), “biodiversity” (926), and “ecosystem” (869)
- Plots of word (phrase) cloud with dependency (left: Q&A; right: Presentation):





# Text-based measurement: Main proxies and alternatives

- Main measures for baseline tests (based on Q&A sections)
  - (a) *Biod perc*:  $(\# \text{ of biodiversity sentences} / \# \text{ of total sentences}) \times 100$
  - (b) *Biod negative perc*:  $(\# \text{ of negative biodiversity sentences} / \# \text{ of total sentences}) \times 100$
  - (c) *Biod positive perc*:  $(\# \text{ of positive biodiversity sentences} / \# \text{ of total sentences}) \times 100$
- Industry-level aggregated main measures
  - Averagely aggregating into NAICS 6-digit level for all sets of measures
- For robustness check, the alternative measures for the three main measures (a)-(c):
  - Variations in calculation: (d) *Negative Score* =  $\# \text{ negative} - \# \text{ positive}$  (Giglio et al. 2023); (e) transcript-level negativity measure (= *Negative Score* if negative, = 0 otherwise); (f) transcript-level positivity measure (=  $- \text{Negative Score}$  if positive, = 0 otherwise)
  - Alternative measures: **frequency measure** instead of percentage measure for (a)-(c); **dummy variable** (negative/positive or not) for (e)-(f)
  - Alternatively, using the **full transcript** instead of only Q&A section for counting

# Bank commitment: Sources of assessment

- *Source 1: Signatories of biodiversity-focused initiatives*
  - Banking Environment Initiative (BEI): launched in 2014; to support zero net deforestation
  - Partnership for Biodiversity Accounting Financials (PBAF): launched in 2019 by a group of financial institutions; to support transparent disclosure on biodiversity
  - Finance for Biodiversity (FfB): launched in 2020 by a group of 26 financial institutions; to support protecting and restoring biodiversity
- *Source 2: Banks' statements in disclosure, assessed by Forest500*
  - Description: a project for assessing companies and financial institutions on deforestation, developed by Global Canopy, a not-for-profit organization
  - Assessment on bank commitment: For each year, Forest500 identifies 150 financial institutions with the greatest deforestation risk exposure, and assesses them on the strength and implementation of their commitments on deforestation, with commitment type and evidence in supporting materials (e.g., annual report) provided

# Bank commitment: Deal-level one-to-one lending relationships

- Reason for building one-to-one lending relationship: to identify the effect of a bank's commitment on the lending to high biodiversity risk firms using syndicated loans
- Procedure
  - *Step 1*: For each loan deal, keep only one observation with the main lead arranger and one largest-earliest tranche
  - *Step 2*: Match lead arrangers with the committed/assessed banks via parent company
  - *Step 3*: Identify the earliest commitment date (or no commitment situation) for the lead banks
- Bank distribution
  - Out of 79 matched banks: 52 banks (65.8%) have claimed or pledged to tackle the biodiversity loss with commitment with a goal; 21 banks (26.5%) only mentioned their understanding of the risk without a goal; 6 banks (7.5%) have made no statement
  - In our loan-level sample from 2010 to 2022: only 25 out of 52 committed banks have post commitment loan records (28.3% of the loan-level observations)

## Bank commitment: Distribution of the earliest commitment year

- (1) signatory to BEI; (2) signatory to FfB; (3) signatory to PBAF; (4) signatory to another imitative; (5) deforestation-free commitment; (6) zero-net deforestation commitment; (7) understanding of the risks (treated as non-committed)

Earliest year	# of banks	# of committed banks	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2010	1								1
2011	1								1
2012									
2013									
2014	8	8	3				5		
2015	3	2					2		1
2016	5	2	1			1			3
2017	2	1						1	3
2018	24	17	1				8	8	7
2019	6	3					2	1	3
2020	8	4		2			1	1	4
2021	4	4		1	2		1		
2022	11	11		4	6		1		
Total	73	52	5	7	8	1	20	11	23
Percentage	100%	71%	6.8%	9.6%	11.0%	1.4%	27.4%	15.1%	31.5%

## Model setting 1: Average effect at loan level

- Objective: to examine the average effect of firm-level risk exposure on loan quantity and costs from 2010 to 2022

$$y_{b,f,t} = \beta_1 Biodiversity\ measure_{f,t-4:t-1} + \theta_1 (Loan\ controls)_{b,f,t} + \theta_2 (Bank\ controls)_{b,t-4:t-1} + \theta_3 (Firm\ controls)_{f,t-4:t-1} + FE + \epsilon_{b,f,t} \quad (1)$$

- $y_{b,f,t}$ : loan-level outcome, including the log of loan amount, the log of maturity, and the rate value of yield spread
- $Biodiversity\ measure_{f,t-4:t-1}$ : three main firm-level measures for overall, negative, and positive biodiversity risk exposure, using moving average value of quarter [-4, -1]

## Loan-level costs: Baseline results

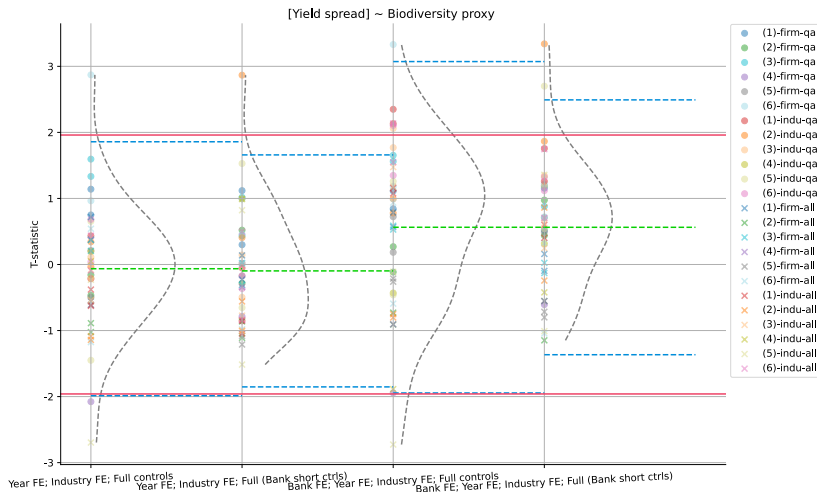
- Below tables show the average effects of firm-level biodiversity risk exposure on yield spread at the loan level
- Explanatory variables: *Biod perc* for columns (1)-(2), *Biod negative perc* for columns (3)-(4), *Biod positive perc* for columns (5)-(6)
- Specifications across all 6 columns: year FE; high-level industry FE; loan controls; bank controls; firm controls

<i>Dependent variable: Yield spread</i>						
<i>Explanatory Variable</i>	<i>Biod perc</i>		<i>Biod negative perc</i>		<i>Biod positive perc</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
Biodiversity measure	0.0371 (0.0325)	0.0292 (0.0263)	-0.00738 (0.0158)	-0.00213 (0.0186)	0.0459 (0.0288)	0.0456 (0.0276)
Bank FE	No	Yes	No	Yes	No	Yes
Obs	1,772	1,772	1,772	1,772	1,772	1,772
adj. R-sq	0.304	0.367	0.303	0.367	0.305	0.368

## Robustness check: Baseline results on loan-level costs

- Definition of t-statistics distribution plot
  - Plots the distribution of t-statistics of the coefficients of all the biodiversity risk measures
  - Number of dots (biodiversity risk measures): 44
  - Two red horizontal solid lines: 1.96 and -1.96
  - Green horizontal dashed line: the mean value of the t-statistics sample
  - Two blue horizontal dashed lines: the mean plus the two standard deviations and minus the two standard deviations, respectively
- Definition of plot legend
  - 24 categories in the legend
  - Each category has three components separated by hyphen in the form of “group number – firm/industry level – Q&A section/full transcript”. Group number (1)-(6) corresponds to the measures (a)-(f)

# Robustness check: Baseline results on loan-level costs (yield spread)

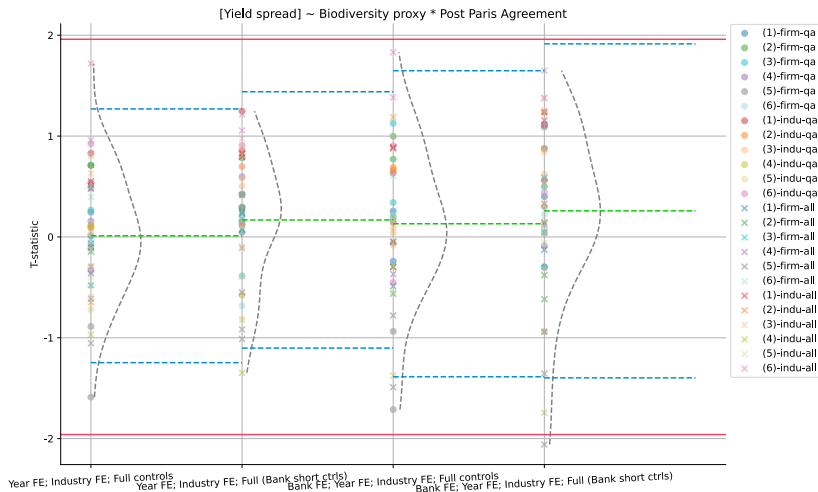




## Additional test: Macro-level event: Paris Agreement

- Paris Agreement: an international treaty on climate change, adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris on 12 December 2015, aiming to enhance the implementation of the UN Framework Convention on Climate Change
- The agreement → policymakers work on green transition → transition risk for brown firms (increased demand for investment; potential punishment from policies) → lower and less stable profitability → higher credit risk
- Objective: to test whether banks realize and react to the increased transition risk of firms with high risk exposure on biodiversity, an important aspect of the environmental concerns, after the Paris Agreement
- Constructing a post Paris Agreement indicator, and show the distribution of t-statistics of the interaction between the biodiversity measure and the post indicator

# Additional test: Macro-level event: Paris Agreement (yield spread)



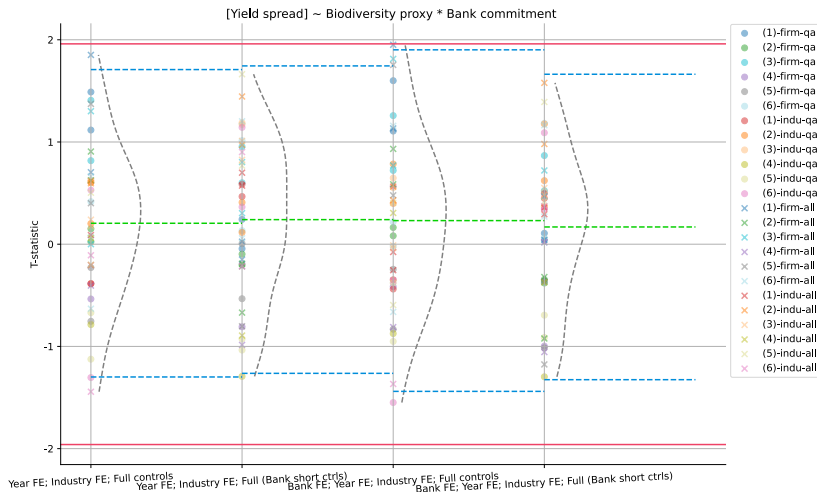
## Model setting 2: The effect of bank commitment

- Objective: to examine whether banks could meet their commitments on biodiversity afterwards, by imposing higher loan costs to borrowers with high biodiversity risk exposure

$$\begin{aligned} y_{b,f,t} = & \beta_1 Biodiversity\ measure_{f,t-4:t-1} + \beta_2 Committed_{b,t} \\ & + \beta_3 Biodiversity\ measure_{f,t-4:t-1} \times Committed_{b,t} \\ & + \theta_1 (Loan\ controls)_{b,f,t} + \theta_2 (Bank\ controls)_{b,t-4:t-1} \\ & + \theta_3 (Firm\ controls)_{f,t-4:t-1} + FE + \epsilon_{b,f,t} \end{aligned} \quad (2)$$

- $Committed_{b,t}$ : an indicator that equals one after a bank has commitment on biodiversity, and zero before that. The indicator always equals zero for banks that never commit on biodiversity

# The effect of bank-level commitment (yield spread)



# Conclusion

- Key takeaways
  - Biodiversity risk measures constructed from the textual analysis on earnings call transcripts of the global firms
  - On average, banks do not care about the biodiversity risk exposure of borrowers in syndicated loans, in terms of price and non-price terms
  - In addition, banks do not significantly change their reaction to biodiversity risk after the Paris Agreement compared to before
  - Banks with commitments on biodiversity do not make significant changes in their lending to high biodiversity risk firms
  - The findings have implications for policymakers on the effectiveness of voluntary biodiversity commitment