Banking on Forest

Hao Zhao (Durham)

Joint with Xian Gu (Durham), Felix Irresberger (Durham), Yun Zhu (St. John's)

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Deforestation of the Amazon rainforest

- By 2022, 26% of the Amazon was deforested view case
- Drivers: Cattle ranching & sugarcane, illegal logging, and agriculture

Sources: (1) Council on Foreign Relations; (fig 1) PARALAXIS on Shutterstock; (fig 2) Erick Caldas Xavier (Wikimedia Commons)

January 2025 Southern California wildfires

- $135-270B economic losses; 16,000 structures destroyed; agricultural damage ▸ view case

Sources: Euronews; Globaledge; Urbanland; Moody's; IQAir; (fig 1) Charles V Payne/X; (fig 2) woodlandsonline; (fig 3) Wikimedia Maps

Forest loss and economy

- **Wildfires (natural disaster)**: 23% of global forest loss
  - Hard to prevent (e.g., McWethy et al. 2019 *Nat. Sustain.*)
  - Threats to economy (e.g., 2018 CA wildfires: 1.5% state GDP damages)
  - Affect firm operation, even being insured (e.g., stated in SEC filings)

- **Human-induced factors**: 77% of global forest loss
  - A deliberate change for economic growth
  - Main factors: commodity, agriculture, forestry, urbanization[1]
  - Driver for carbon emissions (e.g., Houghton et al. 2012 *Biogeosciences*)
  - Regulation: European Union Deforestation Regulation. Proposed 2019; enforced 2023
  - Non-mandatory framework: e.g., REDD+ UNFCCC (2013); OECD-FAO (2016)

[1] Classification of forest loss follows Curtis et al. (2018 *Science*)

What can banks do to mitigate deforestation risks?

- ***Motivation*: banks as a main debt holder in the capital market:**
  - Sensitive to firms' operation/performance
  - Climate change → firm losses → higher credit risk
- **To mitigate *physical risk*:**
  1. Reallocate lending to non-affected firms
  2. Continue lending but increase pricing (e.g., Javadi & Masum 2021 *JCF*)
- **To mitigate *transition risk*:**
  1. Divest from "brown" & reallocate to "green" (e.g., Kacperczyk & Peydró 2021 *WP*)
  2. Continue lending to "brown" → support green transition or increase pricing (e.g., Ivanov et al. 2024 *RFS*)
- We focus on intensive margin instead of extensive (*divestment*)

Main findings

- ***Question*: How banks mitigate the physical risks and transition risks from forest loss**
  - *Assumption*: forest-dependent firms are more affected
- ***Loan pricing***
  - *For realized physical risks*: after fire-induced forest loss, loan spreads for forest-dependent firms increase by 12–65 bps compared to other firms
  - *For transition risks*: after human-induced forest loss, forest-dependent firms get higher spreads after the development of the EU Deforestation Regulation (more for EU banks and firms)

Main findings (*cont.*)

- ***Mechanism*: forest loss and firm operation**
  - Wildfires disrupt operations of dependent firms (↓24.5% operating cash flow)
  - Human-induced loss has no short-term effect, consistent with planned expansion
- ***Ex-post outcome*: green transition after getting loans**
  - Firms that get loans after human-induced loss shift to inputs from countries with lower deforestation risk (responsible sourcing)
  - Evidence of reforestation
  - Evidence of divestiture of pollutive plants

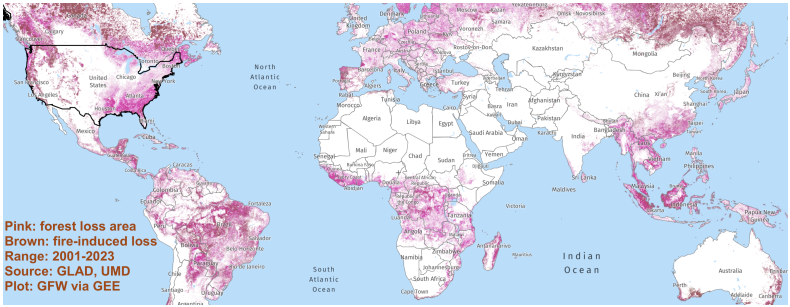
Data and sample overview

- **Key data:**
  - Forest loss (geospatial): GLAD (Hansen et al. 2013 *Science*, Tyukavina et al. 2022 *Front. Remote Sens.*)
  - Forest dependency: ENCORE (UNEP)
  - Syndicated loans: DealScan
  - Supply chains & firm data: Compustat, Refinitiv
  - Reforestation (NDVI): NASA MODIS
  - Deforestation disclosures: Refinitiv AdvFil
  - Plant divestitures: EPA TRI, SDC M&A

- **Sample (loan-level):**
  - 2002–2024; 42,590 obs (large-share lead arranger – deal – earliest tranche level)
  - 6,329 borrowers; 45% U.S., 13% EU, 75% OECD
  - 1,298 lenders; 25% U.S., 17% EU, 60% OECD

Measures for firm-level forest loss

- GLAD laboratory (University of Maryland) geospatial data
  - High-resolution (30-meter) annual data: gross forest cover loss (Hansen et al. 2013 *Science*)
  - From 2000 to 2023, derived from Landsat (NASA) time-series imagery
  - *Definition* of loss: stand-replacement disturbance (forest to non-forest state)



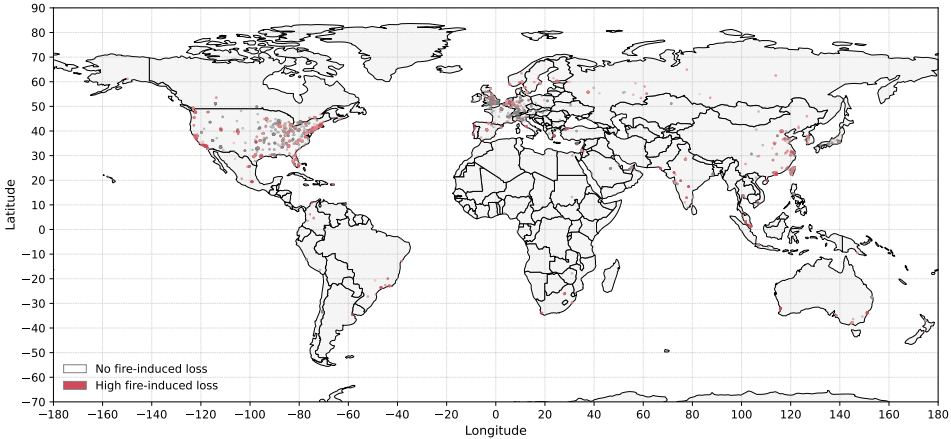
Measures for firm-level forest loss

- Our analyses:
  - (1) Identify firm headquarters' geographic coordinates from address information
  - (2) For each firm, use *Google Earth Engine* to get annual gross forest loss area (in km^2) within 10km around a firm
  - (3) Classify two types of loss: *(a)* forest loss from fires; *(b)* forest loss from human activities (*the loss area not induced by fires*)

Main drivers (global)	**% of total forest loss**	**If external to firms**	**Our variables at firm-level**
Wildfire	23%	Yes	*Fire loss*
Forestry	26%	No	*Human-induced loss*
Shifting agriculture	24%	No	*Human-induced loss*
Commodity-driven	27%	No	*Human-induced loss*
Urbanization	<1%	Unknown	*Human-induced loss*
Total	**100%**		*Annual gross forest loss*

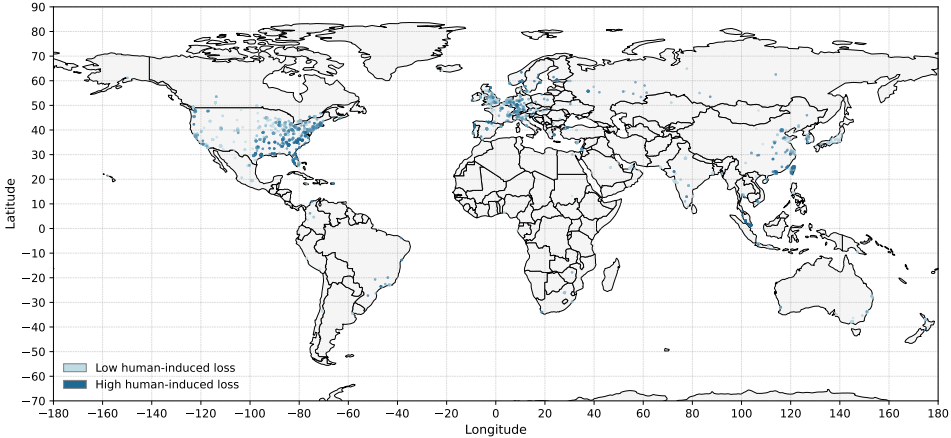
Source for percentages: Classifying drivers of global forest loss, Curtis et al. (2018 *Science*)

Fire-induced forest loss of the sample firms in 2023



Note: The circles on the maps are visually enlarged, and do not represent the actual geographical areas

Human-induced forest loss of the sample firms in 2023



Note: The circles on the maps are visually enlarged, and do not represent the actual geographical areas

Forest dependency of production processes

- ***Goal***: measure how much firms' production directly relies on forests
- ***Reason***: forest-dependent firms are more exposed/related to forest loss
  - e.g., large deforestation happened near *forestry* vs. *tech* firms
- **ENCORE** data framework:
  - Natural capital → Ecosystem services → Industry production processes
  - *Example*: forests → plant materials → forestry production
  - Dependency rating: very low to very high (0–5)
- *Dependency* (our main measure):
  - Select forest-linked ecosystem services → Aggregate at industry (GICS-production process) → Match to borrowers via 2-digit SIC
- *Weighted dependency* (account for country deforestation):
  - $\textit{Dependency} \times (1 + \underbrace{\text{normalized country-level forest loss}}_{\text{= 1 for highest-deforestation country; = 0 lowest}})$

Baseline model: Linking forest loss and loan pricing

- ***Hypotheses*: Banks care about forest loss only when—**
  - **Fire-induced loss** *triggers* realized physical risk (e.g., disruption of raw materials)
  - **Human-induced loss** *triggers* transition risk (e.g., deforestation-related policy scrutiny)
- **Identification logic:**
  - Local variation in forest loss over time (contrasting fire vs. human-induced loss)
  - *Dependency* varies by industry (minimal physical&transition risk if no dependence)
- **Specification** (simplified for presentation):

$$\text{Yield spread}_{b,f,t} \sim \beta_3 \underbrace{(\text{Dependency}_i \times \text{Loss}_{f,t-1})}_{\text{differential pricing (fitted curve)}} + \underbrace{\text{Control variables}}_{\text{loan}_{b,f,t},\ \text{bank}_{b,t-1},\ \text{firm}_{f,t-1}} + \text{FE}$$

  - If $\beta_3 > 0$: yield spread rises more when forest loss increases risk for high-dependency firms

Baseline results

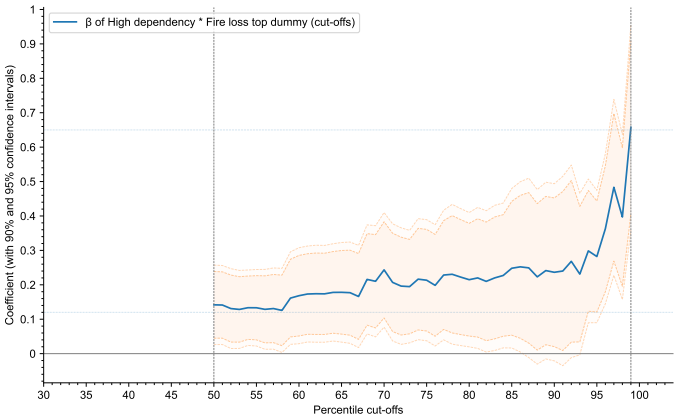
- At *Dependency* mean (0.91): 1 km^2 fire loss → 15 bps higher yield spread

Dependent variable: Yield spread						
Dependency measures	*Dependency*				*Weighted dependency*	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependency measure	-0.00745	-0.00484	-0.00721	0.0000886	0.0703	-0.0359
	(0.0740)	(0.0761)	(0.0758)	(0.0476)	(0.103)	(0.0605)
Fire loss	-0.235*		-0.238*	-0.246*	-0.238	-0.327*
	(0.134)		(0.136)	(0.129)	(0.143)	(0.165)
Anthropogenic loss		0.0349	0.0373	0.0570	0.0574	0.0265
		(0.0439)	(0.0432)	(0.0355)	(0.0480)	(0.0295)
Dependency measure × *Fire loss*	0.425**		0.424**	0.415**	0.527**	0.586**
	(0.176)		(0.183)	(0.177)	(0.230)	(0.261)
Dependency measure × *Anthropogenic loss*		0.00219	-0.00143	-0.0115	-0.0330	-0.0140
		(0.0279)	(0.0288)	(0.0278)	(0.0377)	(0.0290)
High-level industry FE	No	No	No	Yes	No	No
Bank × firm country FE	No	No	No	No	No	Yes
Adjusted R-squared	0.342	0.341	0.342	0.357	0.342	0.515

Note: (1) Obs: 42,590; (2) Year FE/Loan controls/Firm controls/Bank controls/Constant: YES

Robustness: Fire percentile cut-offs

$$\text{Yield spread}_{b,f,t} \sim \beta_3 \underbrace{\mathbb{1}[\text{Dependency}_i > \text{median}] \times \mathbb{1}[\text{Fire loss}_{f,t-1} > \text{cutoff}]}_{\text{differential pricing (discrete effect)}}$$



EU Deforestation Regulation: Transition risk

- **Goal:** Zero deforestation and degradation
  - Ban forest-to-agriculture conversion and unsustainable wood sourcing
- **Due diligence**: Geolocation data, risk assessment and mitigation required
- **Timeline:**
  - July 2019: European Commission proposed regulatory framework
  - June 2023: Entry into force, with 12-month additional phasing-in period
- **Scope:** all firms operating/trading in the EU (products traced to origin)
- **Identification logic**: EUDR increase transition risks for high-deforestation-risk firms
- **Specification** (loan-level; simplified):

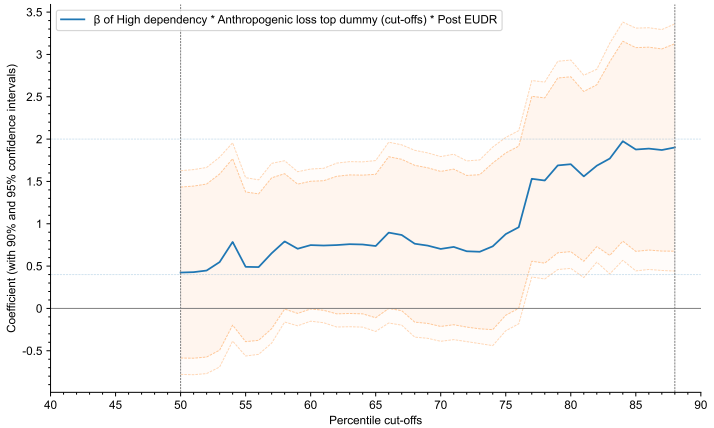
$$\text{Yield spread}_{b,f,t} \sim \beta_7 \underbrace{(\text{Dependency}_i \times \text{Loss}_{f,t-1})}_{\text{differential pricing (fitted curve)}} \times \underbrace{\mathbb{1}[\text{Period} > \text{July 2019}]}_{\text{post-EUDR effect}}$$

  - If $\beta_7 > 0$: deforestation transition risk priced in after EUDR

EUDR policy shock: Findings

- **Global firm sample** ▸ view table
  - Include all firms, since EUDR applies to any firm operating in the EU
  - Post-EUDR: forest-dependent firms with human-induced loss face higher yield spreads
  - No effect for fire loss → reinforces transition-risk pricing channel
- **EU lender–EU operator subsample** ▸ view table
  - Post-EUDR: Stronger differential pricing, with higher magnitude than global sample
  - No pricing response among non-EU lender–firm pairs
- **Policy phase: Framework vs. Enforcement** ▸ view table
  - Pricing sharpens after enforcement (June 2023), compared to post-framework (July 2019)
  - Most visible for EU bank–EU firm pairs

Robustness: Human-induced loss percentile cut-offs



Note: The sample is restricted to EU bank-EU firm lending pairs.

Credit supply side: Do committed banks price forest risk more?

- ***Hypothesis*:** Committed banks (those mentioning deforestation in disclosures) are more responsive to transition risk exposure
- **Design:** Compare four groups: committed vs. non-committed banks, before vs. after EUDR, and re-estimate *Dependency* × *Anthropogenic loss*
- **Findings:** view table
  - Post-EUDR, committed banks charge 17.6 bps higher spreads to forest-dependent firms (at mean 0.9) following 1 km^2 human-induced forest loss
  - No differential pricing pattern for non-committed banks
  - Suggests active pricing role from the credit supply side in response to transition risk

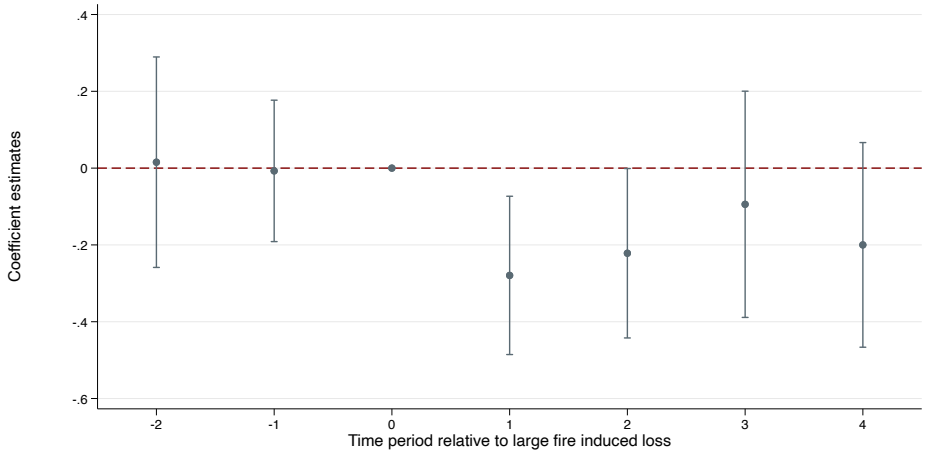
Borrower side: Does firm commitment mitigate pricing?

- ***Hypothesis*:** Firms that disclose deforestation issues may be seen as more risk-aware and committed to mitigation
- **Design:** Compare four groups: committed vs. non-committed firms, before vs. after EUDR, and re-estimate *Dependency* × *Anthropogenic loss*
- **Findings:** view table
  - Post-EUDR, only non-committed forest-dependent firms face 25.2 bps higher spreads following human-induced forest loss
  - No differential pricing pattern for committed firms
  - Results are consistent when using E-score as an alternative commitment proxy

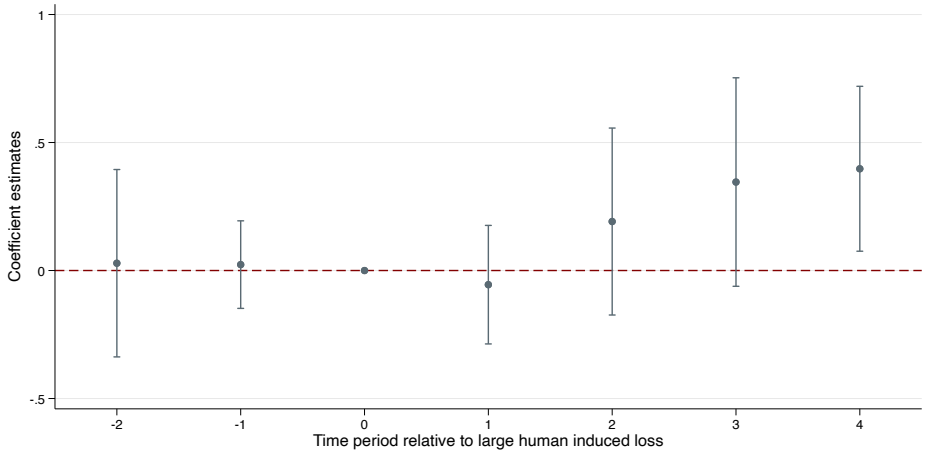
Mechanism: Forest loss and firm operation

- **Motivation:** Wildfires can damage assets & operations (e.g., Portugal 2017 wildfire, Lopes and Póvoa 2022 *J. Real Estate Finance Econ.*)
- **Question:** Do banks price *real disruptions* or just *perceived risk*?
- **Design:**
  - Compare firm operating cash flow before/after large forest loss event
  - *Top dependency* = 1 if in top 30% by forest dependency
  - *Post large loss* = 1 if after large fire or human-induced event
- **Findings:**
  - Fire loss → cash flow declines for forest-dependent firms
  - Anthropogenic loss → no immediate operational impact
  - Suggests banks price fire loss due to liquidity risk, not just perception

Dynamic effects of large fire loss on firm cash flow



Dynamic effects of large human-induced loss on firm cash flow



Ex-post: Do loans facilitate green transition?

- ***Hypothesis***: If **a high-transition-risk firm** (from large human-induced loss) **get loans** → banks and firms might both **engage in green transition** → (1) ***Production*** shift (away from deforestation inputs); (2) ***Reforestation***; (3) ***Divestiture*** of pollutive plants
  - No effect expected after **fire-induced** loss (firms do not have different effect of loan engagement in mitigating transition risk)
- **Specification** (firm-event level; simplified):

$$\text{Outcome}_{f,t+\tau} \sim \beta_3 \underbrace{\mathbb{1}[t > \text{Large anthropogenic loss event}] \times \mathbb{1}[\text{Get loan at } t \text{ or } t{+}1]}_{\text{loan effect after large deforestation event}}$$

  - If $\beta_3 > 0$: loan facilitates post-deforestation adjustment
  - Subsample or interaction tests for high *Dependency* (more exposed)
  - $\tau > 1$: restrict timelines to: loss event → if get loan → future outcomes
  - Balanced 3-year estimation window; exclude overlapping events

Ex-post outcomes and findings

- **Production sourcing** ▸ view details ▸ view table
  - *Supply dependency:* share of inputs from forest-dependent suppliers → **Firms maintain forest inputs — no broad production shift**
  - *Country-adj supply:* inputs from forest-dependent suppliers in high-deforestation-risk countries → **Firms redirect toward responsible sourcing**
- **Environmental recovery** ▸ view table
  - *NDVI (NASA)* greenness index, , or disclosed *reforestation offset programs*: → **Reforestation increases after loans — stronger for high-dependency firms**
- **Asset divestiture** ▸ view table ▸ view discussion on selection and alternative measure
  - *Divestiture of pollutive plants:* pollutive facilities sold after loan receipt → **Firms divest forest-dependent pollutive plants post-loan**

Key takeaways

- Forest-dependent firms face higher loan spreads following fire-induced forest loss
- Human-induced deforestation only leads to higher spreads after the EU deforestation regulation framework is proposed
- Loan recipients with high transition risks respond by:
  - Reducing reliance on forest-based inputs from high-deforestation-risk countries
  - Engaging in reforestation efforts (e.g., NDVI or disclosure-based evidence)
  - Divesting pollutive forest-dependent plants
- Results highlight banks' role in compliance and enabling green transition

Further discussions: Selection, and alternative outcome measure

- Selection into loan receipt
  - Question: what if firms with certain features are also more likely to get loans?
  - Univariate test: the book value of debt of firms that receive bank syndicate loans in a year is significantly higher
  - Selection model: firm-level forest dependency and human-induced forest loss are not significantly correlated with loan receipt (Probit: *If get loan* ~ *Firm characteristics*)
  - Results remain unchanged after controlling for IMR
- Alternative measure of reforestation Back to summary
  - Potential concern: MODIVS NDVI is not a direct measure of firms' actual engagement in reforestation projects
  - Alternative measure: firm disclosure of reforestation activities (keyword dictionary derived from voluntary "Forestry Land Use" carbon offset classifications)
  - Filing coverage: ESG reports, SEC filings, press releases, etc.
  - Findings are robust

Case 1: Impact of 2023 Western Canada Wildfires on Canfor Corp

- *Industry*: Forest products; *Country*: Canada
- Wildfires disrupt pulp & lumber in Alberta & B.C.
  - Q2 2023 loss: $43.9M (vs. $373.8M profit in Q2 2022)
  - Q3 2023 lumber production down 34%
- *Operational Disruptions*
  - 3-week shutdown at Fox Creek, Alberta
  - Severe fiber shortages, haul & harvest delays
- *Financial Impact*
  - Revenue down to $1.45B (from $2.17B YoY)
  - B.C. port strike worsens supply chain
- *Outlook*
  - Wildfire risks persist into late 2023
  - Long-term fiber supply is uncertain

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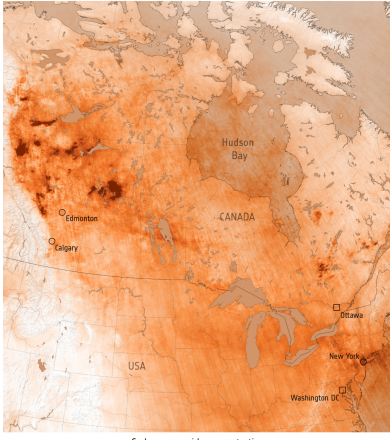

Case 2: Deforestation of JBS

- *Industry*: Meat and food processing; *Country*: Brazil
- *Key impact*
  - JBS linked to large-scale deforestation in Brazil for livestock expansion
  - 1.5M hectares deforested by indirect suppliers in 15 years (size of Northern Ireland)
  - Pantanal wetlands impacted, violating environmental regulations
- *Supply Chain & Compliance Failures*
  - JBS failed to trace indirect suppliers, despite available technology
  - Non-compliance with EU Deforestation Regulation (EUDR) → facing EU trade restrictions
- *Consequences & Outlook*
  - EU sanctions & reputational damage threaten exports
  - Growing pressure from investors & regulators for accountability
  - Unclear if JBS will meet 2025 zero-deforestation goal Back to summary

Policy shock: The introduction of the EUDR

- Loan sample: we start with all firms, as EUDR applies for any firm operating in the EU

Dependent variable: Yield spread				
Loss measure	*Fire loss*		*Anthropogenic loss*	
	(1)	(2)	(3)	(4)
Dependency measure	-0.0257	0.0469	-0.0194	0.0599
	(0.0721)	(0.0980)	(0.0756)	(0.104)
Loss measure	-0.249	-0.241	0.0622	0.0818
	(0.147)	(0.150)	(0.0508)	(0.0532)
Post EUDR	0.0115	0.0558	0.0946	0.148
	(0.110)	(0.110)	(0.140)	(0.143)
Dependency measure × Loss measure	0.455**	0.551**	-0.0184	-0.0519
	(0.202)	(0.248)	(0.0374)	(0.0427)
Dependency measure × Loss measure × *Post EUDR*	-0.588	-1.554	0.261*	0.416**
	(2.136)	(3.066)	(0.126)	(0.185)
Observations	42,590	42,590	42,590	42,590
Adjusted R-squared	0.342	0.343	0.343	0.343

Note 1: Year FE/Loan controls/Firm controls/Bank controls/Constant: YES

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Note 2: Dependency measure: Col (1) & (3) *Dependency*; Col (2) & (4) *Weighted dependency*

Note 3: Other two-way interaction terms are not presented here

EUDR Country heterogeneity: EU bank-EU operators lending pair

- Sample includes borrowers operating in the EU (suppliers to EU & EU firms)

Dependent variable: Yield spread				
Bank country	EU bank (1)	Non-EU bank (2)	EU bank (3)	Non-EU bank (4)
Dependency	-0.126*	-0.135	-0.149	-0.144
	(0.0723)	(0.122)	(0.149)	(0.200)
Anthropogenic loss	0.0696	-0.0716	0.0833	-0.111
	(0.187)	(0.220)	(0.191)	(0.244)
Post EUDR	0.339**	-0.952**	0.365*	-0.891**
	(0.161)	(0.359)	(0.181)	(0.378)
Dependency × Anthropogenic loss	0.0412	0.0624	0.0426	0.158
	(0.176)	(0.236)	(0.298)	(0.415)
Dependency × Anthropogenic loss × *Post EUDR*	1.686**	-0.423	2.568*	-1.016
	(0.643)	(1.382)	(1.168)	(2.796)
Chi-square test	3.0201*		2.7673*	
P-value	0.0822		0.0962	
Observations	6,171	5,671	6,171	5,671
Adjusted R-squared	0.471	0.441	0.469	0.440

Note 1: Year FE/Loan controls/Firm controls/Bank controls/Constant: YES
Note 2: Dependency columns (1) & (3); Weighted dependency columns (2) & (4)
Note 3: Other two-way interactions are not presented

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EUDR: Phase 1 vs Phase 2

- *Post EUDR (phase 1)*: = 1 if the time is between the first deforestation policy framework (23 July 2019) and enforcement (29 June 2023), = 0 otherwise
- *Post EUDR (phase 2)*: = 1 after entering into force (29 June 2023), = 0 otherwise

Dependent variable: Yield spread				
Bank–Firm pair	EU pair	Non-EU pair	OECD pair	Non-OECD pair
	(1)	(2)	(3)	(4)
Dependency	-0.124**	-0.00149	-0.233**	0.0829
	(0.0581)	(0.0791)	(0.111)	(0.103)
Anthropogenic loss	0.133	0.0504	0.137	0.0672
	(0.206)	(0.0444)	(0.206)	(0.0495)
Dependency × Anthropogenic loss × *Post EUDR (phase 1)*	2.260***	0.288	4.201***	0.407
	(0.642)	(0.195)	(1.205)	(0.255)
Dependency × Anthropogenic loss × *Post EUDR (phase 2)*	4.608***	0.186	8.662**	0.333
	(1.608)	(0.113)	(3.112)	(0.251)
Observations	5,518	37,072	5,518	37,072
Adjusted R-squared	0.481	0.338	0.481	0.338

Note 1: Year FE/Loan controls/Firm controls/Bank controls/Constant: YES
Note 2: Col (1)&(3): *Dependency*; Col (2)&(4): *Weighted dependency*
Note 3: Stand-alone time indicators (+sig), two-way interactions, and Chi-sq tests (sig) omitted

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Credit supply side: Bank commitment on deforestation

- *Committed banks*: banks mentioned deforestation in disclosures

Dependent variable: Yield spread				
Bank subsample	Committed	Committed	Non-committed	Non-committed
Subsample period	Pre-EUDR	Post-EUDR	Pre-EUDR	Post-EUDR
	(1)	(2)	(3)	(4)
Dependency	-0.018	0.143	0.040	0.164
	(0.067)	(0.112)	(0.089)	(0.104)
Anthropogenic loss	0.151	-0.282	0.200	-0.227
	(0.132)	(0.173)	(0.141)	(0.279)
Dependency × Anthropogenic loss	-0.037	0.196***	-0.061	0.214
	(0.100)	(0.073)	(0.062)	(0.188)
Chi-square test	3.7972		2.1344	
P-value	0.0513		0.1440	
Observations	3,094	2,932	6,626	2,385
Adjusted R-squared	0.381	0.435	0.278	0.395

Note 1: Year FE/Loan controls/Firm controls/Bank controls/Constant: YES

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Borrower engagement: Firm commitment on deforestation

- *Committed firms*: firms that mention "deforestation" in prior-year disclosures
- Robustness: Use E-score to measure firms' green engagement → similar results

Dependent variable: Yield spread				
Firm subsample	Committed firms		Non-committed firms	
Subsample period	Pre-EUDR	Post-EUDR	Pre-EUDR	Post-EUDR
	(1)	(2)	(3)	(4)
Dependency	-0.197	0.0686	0.0268	0.163
	(0.185)	(0.149)	(0.0845)	(0.106)
Anthropogenic loss	-0.333	0.00833	0.165	-0.374*
	(0.445)	(0.815)	(0.121)	(0.195)
Dependency × Anthropogenic loss	0.931	0.0956	-0.0322	0.252***
	(0.811)	(0.875)	(0.0697)	(0.0940)
Chi-square test	(1)=(2) 0.151		(3)=(4) 6.445**	
P-value	0.698		0.011	
Observations	270	291	9,450	5,026
Adjusted R-squared	0.700	0.562	0.294	0.413

Note 1: Year FE/Loan controls/Firm controls/Bank controls/Constant: YES

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Ex-post outcome: Production

- Examine whether syndicated loans facilitate transition away from forest dependency
- *Supply dependency*: Share of inputs sourced from forest-dependent suppliers
  - Captures shift in production structure (overall forest reliance)
- *Country-adj supply*: Share of inputs sourced from forest-dependent suppliers in high-risk countries
  - Captures responsible sourcing (shift toward lower-risk regions)
- Key idea: If a high-transition-risk firm reduces its deforestation exposure after securing loans, → lenders' engagement role in promoting sustainability
- Empirical design:
  - *Post large anthropogenic loss*: time indicator 3 years around a large human-induced loss
  - *If get loan*: = 1 if firm obtains loan in year t or $t+1$ (capture loans after loss)

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Ex-post outcome: Production (*continued*)

Dependent variable	*Supply dependency*		*Country-adj supply*	
Outcome window (forward)	+3 years	+4 years	+3 years	+4 years
	(1)	(2)	(3)	(4)
If get loan (t or t+1)	0.0593**	0.0634**	0.111**	0.115**
	(0.0273)	(0.0295)	(0.0417)	(0.0440)
Post large anthropogenic loss	0.0423*	0.0396	0.0613	0.0577
	(0.0235)	(0.0243)	(0.0387)	(0.0402)
If get loan × *Post large anthropogenic loss*	-0.0426*	-0.0437	-0.0703**	-0.0711**
	(0.0225)	(0.0277)	(0.0250)	(0.0321)
Observations	523	523	523	523
Adjusted R-squared	0.330	0.345	0.349	0.365

Note 1: Year FE/Firm controls/Constant: YES

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Note 2: Window restriction: no other large loss event three years around a selected large loss event

Note 3: No production change around large fire loss

Ex-post outcome: Reforestation

- *Outcome*: NDVI (Normalized Difference Vegetation Index) — greenness of vegetation
  - From NASA MODIS, primarily used to determine land use and land-cover change (LULCC)
- *Post large anthropogenic loss*: = 1 if three years after a large human-induced forest loss
- *If get loan*: = 1 if a firm obtains a loan in t or t+1 following large loss

Dependent variable: NDVI				
Outcome window (forward)	+1 year	+2 years	+3 years	+4 years
	(1)	(2)	(3)	(4)
If get loan (t or t+1)	-0.224	-0.184	-0.150	-0.0940
	(0.710)	(0.701)	(0.697)	(0.696)
Post large anthropogenic loss	-2.271*	-2.059	-1.918	-1.781
	(1.314)	(1.360)	(1.395)	(1.393)
If get loan × *Post large anthropogenic loss*	1.174***	1.215***	1.200***	1.126***
	(0.334)	(0.359)	(0.359)	(0.359)
Observations	4,322	4,322	4,322	4,322
Adjusted R-squared	0.178	0.176	0.170	0.163

Note 1: Year FE/Firm controls/Constant: YES

Note 2: Window restriction: no other large loss event three years around a selected large loss event

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Ex-post outcome: Reforestation (High dependency subsample)

Dependent variable: NDVI				
Outcome window (forward)	+1 year	+2 years	+3 years	+4 years
	(1)	(2)	(3)	(4)
If get loan (t or t+1)	0.727	0.796	0.858	0.928
	(1.053)	(1.045)	(1.044)	(1.053)
Post large anthropogenic loss	-2.230	-1.944	-1.869	-1.745
	(1.662)	(1.690)	(1.708)	(1.684)
If get loan × *Post large anthropogenic loss*	1.555**	1.575**	1.595**	1.525**
	(0.593)	(0.620)	(0.632)	(0.646)
Observations	2,303	2,303	2,303	2,303
Adjusted R-squared	0.193	0.189	0.183	0.177

Note 1: Year FE/Firm controls/Constant: YES

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Note 2: Window restriction: no other large loss event three years around a selected large loss event

Ex-post outcome: Divestiture of pollutive plants

- Examines if firms divest pollutive forest-dependent plants after human-induced loss
- Focus on U.S. public firms with TRI-listed plants; divestiture scaled by 100 (pp change)
- Evidence: Firms receiving loans are more likely to divest forest-linked pollutive assets, especially with high forest dependency

Dependent variable: Divestiture						
Type of divested plants	Nonzero forest dependency			High forest dependency		
Outcome window (forward)	+2 yrs	+3 yrs	+4 yrs	+2 yrs	+3 yrs	+4 yrs
	(1)	(2)	(3)	(4)	(5)	(6)
Dependency × Anthropogenic loss × If get loan	1.095***	1.118***	1.215***	1.090***	1.123***	1.210***
	(0.282)	(0.304)	(0.390)	(0.279)	(0.299)	(0.384)
Observations	7,313	7,313	7,313	7,313	7,313	7,313
Adjusted R-squared	0.0129	0.0198	0.0233	0.0152	0.0223	0.0255

Note 1: Year FE/Firm controls/Constant: YES

Note 2: Stand-alone variables and two-way interactions are not presented here

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