

Nature-Related Risks in Syndicated Lending

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Abstract

Firms highly dependent on ecosystem services incur 0.32% higher loan spreads for every 1% increase in nature dependency. To support a causal interpretation, we exploit the 2019 amendment to the Endangered Species Act (ESA), which relaxed protections for threatened species and their habitats. Following this regulatory change, loan spreads declined for firms whose nature dependency stems from ecosystem services linked to protected areas and key biodiversity areas. We find no association between loan spreads and firms' impact on nature. Our results suggest that nature-related risks are internalized by financial markets, although the effect is modest. We also highlight the role of refinancing risk in how banks price nature dependency of borrowers.

Keywords: nature, risk, syndicated loans, debt

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1. Introduction

Do banks price firms' dependency on nature, their impact on it, or both? We provide evidence from the US syndicated loan market. Banks charge higher loan spreads to firms that depend more heavily on nature for their operations. Using the 2019 amendment to the Endangered Species Act, which relaxed protections for threatened species and their habitats, we find that loan spreads declined for firms whose nature dependency stems from ecosystem services linked to protected areas and key biodiversity areas. By contrast, we find no evidence that banks price firms' impact on nature.

This asymmetry is economically intuitive. Dependency creates direct balance sheet exposure: when ecosystem services fail, firms face operational disruptions that impair cash flows and increase default probability. Impact, by contrast, generates costs that firms can largely externalize under current regulatory regimes. A firm that degrades local ecosystems does not automatically bear the financial consequences. Until legal frameworks evolve to internalize these externalities, banks have limited incentive to price impact risk. This finding has implications for whether financial markets can discipline environmentally harmful activities.

A recent example illustrates the operational consequences. Tesla's Berlin gigafactory faced construction delays when a German state court halted work over concerns about its potential to strain already declining groundwater levels and affect nearby forests and communities.¹ Tesla's Austin facility similarly required erosion control measures to

¹See: <https://tinyurl.com/fortune-tesla-gigafactory>

prevent runoff into the Colorado River.² Mass stabilization, an ecosystem service that naturally prevents soil erosion through vegetation, proved essential to both projects. These cases demonstrate that firms whose activities depend on local ecosystems face substantial disruptions with financial consequences.

These findings matter because banks are major providers of external capital globally, and natural capital is declining rapidly. From 1992 to 2014, per capita natural capital fell by nearly 40% worldwide (Dasgupta, 2021). The estimated biodiversity financing gap alone is between \$700 billion and \$967 billion annually (Karolyi and Tobin-de la Puente, 2023). Banks' clients face two primary types of nature-related risk. Physical risks arise when firms depend on ecosystem services that may degrade or become unavailable. Transition risks emerge when governments or markets take action to protect natural capital, potentially restricting firms' activities or raising compliance costs.

We study 1,708 syndicated loan tranches for 662 publicly traded US firms from Thomson/Refinitiv LoanConnector. The sample begins in 2016, following the adoption of the Paris Agreement and Sustainable Development Goals. We exclude financial and utility firms due to their regulated nature. The average loan spread is 191 basis points. The measure of dependency on nature and ecosystem-related services comes from the S&P Sustainable1 database, the result of a collaboration between S&P Global and scientists from the United Nations Environment Programme (UNEP) to map nature-related risks for each firm. The methodology assigns each firm a *material dependency* score ranging

²See: <https://tinyurl.com/tesla-austin-gigafactory>

from 0 to 1 across 21 ecosystem services, drawing on the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) knowledge base. The score captures how disruption of each ecosystem service would affect the financial viability of a firm’s production processes, aggregated using revenue weights. For the impact score, S&P uses the “condition-adjusted area” metric, which measures the reduction in ecosystem health due to company activities, providing a standardized scale for impact. The data are cross-sectional and do not vary over time. We describe the methodology in detail in Section 2.

Ex ante, the relationship between loan spreads and nature related risks is ambiguous. Banks might ignore these risks entirely if they lack standardized metrics and the causal chains linking ecosystem degradation to firm cash flows remain poorly understood. Alternatively, banks might already price these risks through established frameworks such as the Equator Principles, IFC Performance Standards, and sector specific environmental guidelines that mandate due diligence for projects affecting for example water resources, biodiversity, and habitat integrity. The relationship could also differ between dependency and impact. Regulatory leniency allows high impact firms to externalize environmental costs, potentially making them appear less risky from a narrow credit perspective. For dependency, however, this logic does not apply. Exposure to ecosystem degradation persists regardless of regulatory stance. A firm dependent on stable ecosystem services faces operational risk if those services deteriorate, irrespective of whether regulators penalize environmental damage. We would therefore expect a positive or null relationship for

dependency, but the sign for impact is ambiguous.

Our baseline results show that loan spreads are positively correlated with the materiality of a firm’s dependency on natural capital and ecosystems. A 1% increase in material dependency score corresponds to a 0.32% increase in loan spreads, roughly 0.61 basis points from the mean spread of 191 basis points. We find no statistically significant relationship between loan spreads and firms’ impact on nature. In the strictest specification, we incorporate lender \times industry \times time fixed effects to capture both lender and industry-specific time-varying unobserved factors that might confound the results. Following the existing literature, we also control for other loan-level characteristics. Across all these specifications, we continue to obtain similar results.

These baseline results could reflect omitted variables correlated with nature dependency rather than dependency on nature itself. We address this concern using the 2019 amendment to the Endangered Species Act as a natural experiment. First enacted in 1973, the ESA aimed to protect vulnerable animal and plant species categorized as either ‘endangered’ or ‘threatened’. Importantly, the ESA also makes it illegal to damage the natural habitat of an endangered species (Lueck and Michael, 2003). However, these protections were weakened in 2019 when the Trump administration relaxed endangerment classification criteria and eliminated automatic protections for “threatened” species, reducing regulatory and liability risks for firms operating near protected areas and key biodiversity areas. From a lender’s perspective, this policy shift may have diminished the perceived riskiness of borrowers with high ecosystem service dependency. By taking

advantage of this policy change, we can better isolate the specific effect of natural capital dependency on loan spreads, separate from other concerns.

Using a difference-in-differences approach, we examine whether the loan spreads for firms that are more exposed to protected and/or key biodiversity areas changed relative to others after the ESA amendment. We find that loan spreads for these firms declined in the four quarters following the 2019 ESA amendment, compared to the period before. A 1% higher material dependency score is associated with a 0.25% to 0.30% decrease in loan spreads after the policy change. Like our previous specifications, we include lender \times industry \times time fixed effects, reducing the likelihood that unobserved, time-varying shocks at the lender or industry level bias our findings. We also find little evidence of pre-trends, supporting a causal interpretation. In additional (unreported) robustness checks, we confirm that the results hold when controlling for climate change exposure, ESG ratings, and when using an alternative definition of ecosystem services linked to protected and/or key biodiversity areas. Overall, these findings suggest that lenders took firms' nature-dependency into account in their lending decisions following the ESA amendment. However, nature-dependency may still correlate with other unobserved firm characteristics, so we are cautious in making strong causal claims.

We provide additional validation. First, although our S&P measure is cross-sectional, nature dependency is highly stable over time. Using the time-varying measure recently introduced by Garel et al. (2025) (GRSW, henceforth), we find that nature dependency correlates 0.99 with its one-year lag and 0.90 even over a five-year lag. Second, we docu-

ment that even though the S&P and GRSW measures are only weakly correlated (0.38), reflecting their distinct weighting methodologies that capture different slices of firm characteristics, we find qualitatively similar results when using the GRSW measure. Because both measures originate from the underlying ENCORE framework, they can be viewed as noisy proxies for the same latent nature dependency risk. The consistency of our findings across both measures therefore strengthens the interpretation that banks are pricing a common underlying risk factor rather than artifacts of any particular measurement approach. Third, we examine which ecosystem services drive the results. Grouping the 21 services into Regulating, Provisioning, and Supporting categories following Costanza et al. (1997), we find that banks price regulating services, which account for roughly 60% of total ecosystem value (Pascual et al., 2010; Kurth et al., 2021). This distinction is economically meaningful. Provisioning services allow substitution: firms can switch suppliers or find market alternatives. Regulating services such as climate regulation and water purification cannot be purchased as commodities. If these services deteriorate, firms face prohibitive costs to engineer substitutes or fundamental threats to operations. That banks price non-substitutable dependencies rather than applying blanket environmental penalties indicates sophistication in assessing nature-related exposures. This interpretation is consistent with sector-specific guidelines under frameworks such as the Equator Principles and IFC Performance Standards, which mandate enhanced due diligence for projects. Fourth, we explore the association with nature-related risks and other loan terms. Consistent with banks perceiving firms with higher nature-dependency as risky,

they reduce loan maturity and are more likely to issue secured loans for firms with higher nature-dependency. Finally, we verify that our results hold when the sample is restricted to recent years, post-2017 as well as post-2020. This is consistent with the idea that nature-related risks have become more prominent in recent years, further validating the relevance of our findings.

Our results are robust to controlling for ESG ratings and climate change exposure, suggesting that banks respond specifically to nature dependency rather than broader sustainability metrics. The results also hold when excluding COVID-19 years. We also find evidence on the mechanism. Nature-dependent firms with higher short-term debt face elevated spreads, suggesting that banks price refinancing risk for borrowers.

We contribute to several strands of literature. First, our study complements a growing body of literature that looks at how nature and biodiversity risks affect financial markets. Karolyi and Tobin-de la Puente (2023) highlights the importance of understanding the impact of such risks in financial markets. Existing studies have analyzed how biodiversity risks are priced in common stocks (e.g., Giglio et al., 2023; Coqueret and Giroux, 2023; Garel et al., 2024), in syndicated loans (e.g., Erten and Ongena, 2024; Deng and Lin, 2025), in municipal bonds (Chen et al., 2023), and in the credit default swap (CDS) market (Hoepner et al., 2023). Although closely related, nature-related risks encompass both biodiversity risks and the broader spectrum of physical risks from degradation of all natural capital (e.g. land, water, climate). This issue has also been highlighted in a recent paper investigating nature dependence of global firms by Garel et al. (2025). Additionally,

Gjerde et al. (2025) survey portfolio companies of a large institutional investor where 48% of the respondents believe nature-related risks are financially material. We extend this literature by showing that banks price firms' dependency on nature. More broadly, our study is related to the extensive literature on environmental, social, and governance (ESG) issues in finance.

Second, our study also relates to the broader literature on banking. Specifically, it relates to research on how climate transition risk and environmental disclosures influence lending decisions (Giannetti et al., 2023; Kacperczyk and Peydro, 2021; Houston and Shan, 2022; Basu et al., 2022; Buchetti et al., 2024). We add to this by examining the syndicated loan market, investigating how banks' lending decisions are affected by firms' dependencies on nature and its ecosystems.

Beyond the literature contributions, our study provides evidence on double materiality in credit markets and offers methodological validation. The ENCORE-based material dependency measure aggregates ecosystem service exposures using a sales-weighted approach. Banks operationalize frameworks such as the Equator Principles and IFC Performance Standards through sector-specific environmental guidelines. The alignment between the ENCORE-based measure and established bank risk assessment practices suggests that our findings reflect deliberate application of due diligence protocols rather than incidental correlation.

Our findings demonstrate that banks incorporate nature-related risks into lending decisions, but we cannot assess whether the pricing is sufficient. Nature dependency may

give rise to systematic risks affecting multiple firms simultaneously. If such correlated shocks materialize, the modest risk premia we document may prove inadequate. We leave the question of whether current pricing reflects the true systematic component of nature-related risks to future research.

2. Data Description

2.1. Nature-related Data

Our measure of dependency on nature and ecosystem related services comes from the S&P Sustainable1 database. The database assigns each firm a *material dependency score* ranging from 0 (no dependency) to 1 (very high dependency) across twenty one ecosystem services. The materiality component draws on the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) knowledge base, which assesses how the disruption of each ecosystem service would affect the functionality and financial viability of different production processes. Each production process within a sub sector receives an ENCORE score for every ecosystem service. To illustrate, consider the ecosystem service of ground and surface water supply within the dairy processing sub sector. The ENCORE framework assigns different dependency scores to each production process: raw milk collection receives a score of 0.8, pasteurisation receives 0.6, and packaging receives 0.4. These scores reflect how water dependency decreases as dairy production moves from initial collection through to final packaging.

When aggregating production process scores to the sub sector level, the methodology distinguishes between complementary and supplementary processes. For complementary

processes, where disruption to any single process would hinder overall production, the maximum score across processes is taken to represent the sub sector. In the dairy processing example, since raw milk collection, pasteurisation, and packaging are all necessary to produce the final product, the sub sector receives a score of 0.8 (the maximum) for its dependency on ground and surface water supply. In contrast, for sub sectors where production processes are mutually exclusive or supplementary (such as different energy generation technologies within the electricity sector), the average of process level scores is used instead. The firm level score is then calculated by decomposing total turnover into economic sectors and aggregating the materiality scores weighted by revenue share. We use the natural logarithm of 1 plus the material dependency score.

This aggregation approach differs from the methodology employed by Garel et al. (2025), who use an average of ENCORE scores across all production processes regardless of their complementary or supplementary nature. This methodological distinction contributes to the differences in correlation between our measure and theirs documented in Appendix of this paper. The data are cross-sectional and do not vary over time.

Similar to the nature dependency scores, S&P also calculates the nature impact scores based on the geographical location of business activities of a firm. Following the scientific convention, "condition- adjusted area" is used as a metric to measure a firm's impact on nature. Measuring "condition-adjusted area" means assessing the total area of an ecosystem and then adjusting this area based on its health compared to an undisturbed state. For example, if 100 hectares of forest are only in half as good condition as an

untouched forest, the area is counted as the equivalent of 50 hectares of intact forest in terms of biodiversity. The impact of a business activity on an ecosystem is then measured by calculating the reduction in the condition-adjusted area caused by that activity. This approach translates the environmental impact into an "equivalent loss" of intact ecosystem area, capturing how much of the ecosystem's biodiversity or service value is effectively diminished due to the business's operations. The measure is expressed in hectares. Higher the number, higher is the impact of the business on its surrounding ecosystems. We use the natural logarithm of 1 plus the impact score in our analysis, consistent with our transformation of the dependency measure.

A potential concern is measurement error. When asset-level data are unavailable, S&P relies on assumptions, such as estimating an asset's economic activity using revenue or production value-based modeling.³ S&P also makes certain assumptions when calculating company-based scores. For instance, it uses Trucost Environmental and GeoSeg datasets to estimate land use in hectares for calculating impact and dependence on land use. To check whether the nature-dependency and impact scores largely accurately reflect nature dependency and impact, we present anecdotal evidence and discuss more characteristics of the data in the sub-section (2.5).

To illustrate, Tesla has a high material dependency score reflecting its high reliance on ecosystem services like groundwater, flood and storm protection, and erosion control. This is highlighted by its Berlin gigafactory delays due to groundwater usage and its

³https://portal.s1.spglobal.com/survey/documents/SPG_S1_Nature_Bio_Risk_Methodology.pdf

Austin facility’s proximity to a flood-prone zone⁴. Regarding its environmental impact, Tesla’s condition-adjusted area is largely influenced by its proximity to key protected areas, as seen in the location of its Berlin Gigafactory near a forest home to protected wildlife, where construction was temporarily halted by a court due to deforestation concerns.⁵

Apart from GRSW, we are unaware of other such data. For example, Garel et al. (2024) uses the direct and indirect impact of firms with proprietary data, while Giglio et al. (2023) employs a news index-based measure of biodiversity risk for equities. Similarly, Hoepner et al. (2023) uses data from a proprietary ESG data provider that does not include firms’ dependency on nature and its ecosystem services. Additionally, as discussed in Garel et al. (2024), MSCI’s data coverage is relatively narrow, focusing only on land use and biodiversity without offering a more comprehensive set of measures.

A potential concern is that the S&P data is cross-sectional. Hence, if nature-dependency and impact changes for firms then it would induce a look-ahead bias in our analysis. In this respect, GRSW provide a time-varying nature-dependency measure. First, in Table (A1) we document that either in the entire US sample of GRSW (Panel A) or in the sample of firms in our analysis (Panel B), the correlation of one-year lagged nature-dependency score is roughly 0.98. This persists, even at a five-year interval when the correlation is 0.90. The high persistence of nature dependency scores is unsurprising. These measures reflect the fundamental nature of firm operations, which typically evolve

⁴See: <https://tinyurl.com/austin-tesla-groundwater>

⁵See: <https://tinyurl.com/tesla-berlin-gigafactory>

gradually rather than shifting abruptly. This stability mitigates concerns about look ahead bias from using cross sectional data. Moreover, as we discuss later, our results hold when using the alternative GRSW measure, even though the two measures are only modestly correlated in our sample. This suggests that our findings capture a robust underlying relationship rather than idiosyncrasies of a particular measure.

Our nature related measures also differ notably from traditional ESG scores. As shown in Table (3), the correlations between nature dependency, nature impact, and MSCI’s Environmental, Social, and Governance scores are uniformly low. This suggests that our measures capture a distinct dimension of environmental risk not reflected in standard ESG metrics. ESG scores primarily assess company policies, social responsibility, and governance practices. By contrast, our measures quantify the physical and operational linkages between firms and natural ecosystems. This distinction is important because dependence on ecosystem services represents a tangible source of business risk that conventional ESG frameworks may overlook.

Two features make the S&P data well suited for our study. First, it includes both dependency and impact measures that are not strongly correlated in our sample, allowing us to examine different aspects of nature-related risk simultaneously. Second, the dataset aligns with our sample period and is grounded in the concurrent Exploring Natural Capital Opportunities and Exposure (ENCORE) framework, which reflects the understanding of nature-related risks available at that time. This allows us to limit potential bias by ensuring that our measures do not incorporate information that was unavailable in the

earlier years of the analysis.

2.2. Loan-level Data

We obtain data on private loan contracts from Thomson/Refinitiv LoanConnector. We focus on deals arranged by US lenders between 2016 and 2023 in US Dollar currency and identify pricing and non-pricing characteristics of each loan. Our sample begins in 2016, as it marks the year following the adoption of the Paris Agreement and the introduction of the Sustainable Development Goals (SDGs), both of which established ambitious global frameworks to address major environmental and social challenges. Following Ertan (2022), we treat the loan tranche as our unit of observation, because loan pricing and other key variables, such as amount and maturity, are defined at the tranche level. Conducting the analysis at the tranche level is consistent with the late-2021 revamp of DealScan, when LoanConnector DealScan replaced the legacy version. The new platform provides a pre-merged table that contains all variables, eliminating the need for additional linking tables. In this dataset, a tranche corresponds to what was called a facility in legacy Dealscan, keeping our study fully aligned with prior literature and established methodologies.⁶ We code an indicator variable specifying the loan purpose, collateral, and callable status. Our primary variable is the cost of borrowing defined as the natural logarithm of the loan spread for firm i over time t ($SPREAD_{it}$) at the time of loan origination (Graham et al., 2008; Bharath et al., 2011; Ertugrul et al., 2017). We use the

⁶Please see on WRDS section WRDS Overview on DealScan (LoanConnector) located at Support/Manuals and Overviews/ LSEG / WRDS-LSEG DealScan/ WRDS Overview on DealScan (LoanConnector)

unlogged measure of loan spreads in basis points (bps) for descriptive purposes.

2.3. Other Financial Data & Sample Construction

We obtain financial measures using data from Refinitiv. We exclude financial (SIC 6000 – 6999) and utility (SIC 4900 – 4949) firms from our sample due to their regulated nature. Our final sample includes 1,708 firm-tranche observations for 662 publicly traded firms. To mitigate the effect of extreme values, we winsorize continuous variables at the 1st and the 99th percentiles.

2.4. Control Variables

We employ the standard firm level variables which are lagged by one quarter to control for conditions that are observable at the time lending spreads are set. Our firm level variables include firm size (Size); growth opportunities, as reflected by the market-to-book ratio (MTB); leverage (Leverage); tangibility of assets (Tangibility); operational risk, as reflected by the standard deviation of profitability (St.Dev(Profitability)); bankruptcy risk, as reflected by Altman’s Z-Score (Z-Score); and firm profitability (Profitability). Because analysts may reduce monitoring costs, we also control for analyst following (Analyst) (Barth et al., 2001). In addition, we control for sales growth (Sales Growth). We control for firm maturity (Firm Maturity) to better identify the effects specific to firms’ life cycle (Bradley et al., 2016; Amin et al., 2023). We provide variable definitions in the Appendix.

We also control for loan maturity (Loan Term), loan size (Loan Size), and whether or not the loan is secured (Secured) or is callable (Callable). Our model includes fixed

effects that control for the various purposes of loans issued. We include period fixed effects (calendar-semiannual) to control for temporal differences in the macroeconomic environment when loans are issued. Detailed variable definitions are in the Appendix.

2.5. Summary Statistics

Table (1) presents summary statistics. The mean loan spread is 191 basis points with a standard deviation of 130 basis points, indicating substantial cross-sectional variation. The average loan maturity is 50 months with 28% of loans secured. For nature-related variables, the mean material dependency score is 0.36 and the mean impact score is 4.08. The three ecosystem service categories show varying average dependencies: regulating services (0.12), provisioning services (0.07), and supporting services (0.06).

[Insert Table (1) here]

Additionally, we also present some broader industry-level summary statistics in Table (2). Panel A of the table documents the distribution of our sample observations across different Fama and French 12 industries. While we use the Fama and French 48 industry classifications throughout the paper, we have condensed the classification to 12 industries in this panel for improved readability. In Panel B, we identify the five most nature-dependent industries in our sample, ranked based on their average nature-dependency scores within the Fama and French 48 industry classification. Lastly, Panel C highlights the five industries with the highest impact on nature.

[Insert Table (2) here]

In Table (3), we also provide a cross-correlation table for the nature-dependency and impact measures alongside the MSCI E, S, G, and overall ESG scores. This analysis shows that the nature-related measures only have moderate correlations with the ESG scores, indicating they capture unique aspects of firms’ environmental interactions. Additionally, the moderate correlation (0.15) between nature-dependency and impact suggests that firms highly dependent on nature do not necessarily exert a higher impact on nearby natural ecosystems, highlighting that these dimensions represent distinct relationships with nature.

[Insert Table (3) here]

3. Baseline Empirical Results

We estimate:

$$\begin{aligned}
 LnSpread_{i,b,j,l,t} = & \alpha + \beta_1 Material\ Dependency_i + \beta_2 Impact_i + \\
 & \beta_3 X_{i,t-1} + \gamma X_{il} + \phi_{jl\tau} + \epsilon_{i,b,j,l,t} ;
 \end{aligned}
 \tag{1}$$

where $LnSpread$ is the natural logarithm of the loan spread in basis points for firm i in time t in industry j from lender b in loan tranche l . The independent variables of interest are $Material\ Dependency$ and $Impact$ for the firm i . We control for firm-specific variables denoted by $X_{i,t-1}$ for the quarter before the loan spreads are set. We also control for loan controls X_{il} . In our strictest specification, we employ industry–lender–time fixed effects ($\phi_{jl\tau}$). This captures both lender and industry-specific time-varying factors that

might drive loan spreads other than nature dependency.

[Insert Table (4) here]

Table (4) presents baseline results. Across all models, the coefficient on *Material Dependency* is both positive and statistically significant, indicating that firms with higher dependency on ecosystem services are perceived as riskier by lenders. In our strictest specification, we include $Lender \times Industry \times Time$ fixed effects in column (5). This specification helps us to control for supply-side factors, ensuring that our results are not driven by differences in credit availability across lenders, variations in industry-specific lending conditions, or time-specific shocks that may influence loan supply. In this specification, we obtain a point estimate of 0.32 implying that a 1% increase in the natural dependency score is associated with a 0.32% increase in loan spreads. However, in absolute terms, the economic effect is modest. The point estimate would suggest an increase of 0.61 basis points ($= 0.32\% \times 191$) in loan spreads from the average loan spread for 1% increase in the nature-dependency score. Unlike nature-dependency, we don't find any association between firms' impact on natural ecosystems and loan spreads as implied by the small and statistically insignificant coefficients of the point estimate on *Impact* in the table. We use a calendar half-year as the time unit for the fixed effects in our analysis to avoid having our point estimates driven by sparse cells. However, our results remain consistent even when using calendar quarters as the time unit, as shown in Table (A5).

3.1. Identification

The results in Table (4), while robust, could still be influenced by omitted variables. For example, if nature dependency correlates with higher pollution or weak governance, it's possible that lenders are reacting to these factors rather than adjusting loan spreads based solely on nature dependency. To address this concern, we leverage the U.S. government's 2019 amendment to the Endangered Species Act (ESA) as a natural experiment.

The 2019 amendment relaxed ESA protections by redefining "endangered" and "threatened" classifications and permitting commercial operations in previously protected habitats. This reduced regulatory and liability risks for firms operating near protected areas. From a lender's perspective, the policy shift diminished the perceived riskiness of borrowers with high ecosystem service dependency, providing plausibly exogenous variation in the cost of nature dependency.

Not all firms were equally affected. Firms whose ecosystem service dependencies are linked to protected areas and key biodiversity areas faced greater exposure to this regulatory change. We therefore classify the 21 ecosystem services by their association with protected areas and key biodiversity areas. For this classification, we use Watson et al. (2014) to classify the following ecosystem services to be most likely to be associated with protected areas and/or key biodiversity areas: Bio Remediation, Buffering & Attenuation of Mass Flows, Climate Regulation, Disease Control, Filtration, Flood & Storm Protection, Ground Water, Maintain Nursery Habitats, Mass Stabilization & Erosion Control, Pest Control, Pollination, Soil Quality, Water Flow Maintenance, and Water Quality. In

Table (A3) in the appendix, we provide rationale for including each of the ecosystem services. For each firm, we calculate the average nature–dependency measure for each of the ecosystem services. We then classify firms having the average score greater than the median as being highly dependent on nature-related services that are in turn related to protected areas and/or key biodiversity areas.

To exploit the ESA, we focus on six quarters before and after the quarter when the change was made. We then estimate the following regression:

$$\begin{aligned}
 LnSpread_{i,b,j,l,t} = & \alpha + \beta_1 High\ Material\ Dependency_i + \beta_2 After\ ESA + \\
 & \beta_3 High\ Material\ Dependency_i \times After\ ESA + \phi X_{i,t-1} + \\
 & \gamma X_{il} + \phi_{jl\tau} + \epsilon_{i,b,j,l,t} ;
 \end{aligned} \tag{2}$$

where *After ESA* is a dummy variable that takes the value of 1 for quarters after the ESA amendment and zero for the quarters before. *High Material Dependency* is a dummy variable that takes the value of 1 for firms with greater than median average score of nature-dependency for the ecosystem services that are most likely to be related to protected areas and/or key biodiversity areas. Other variables are defined in the same way as in Equation (1). We also control for a change in loan spreads associated with the impact of a firm on the natural ecosystems after the regulation by including the interaction term *Impact* × *After ESA* in the vector of control variables \mathbf{X} . By relaxing the strict criteria for classifying species as endangered or threatened and permitting commercial

activities in previously protected ecosystems, the amendment made it less risky for firms relying heavily on nature to operate. The amendment reduced the regulatory burden and litigation risk for firms operating near protected habitats. If banks price nature dependency, this reduction in risk exposure should translate into lower loan spreads for highly dependent firms after the policy change. Hence, we would expect banks to lower loan spreads for firms with higher natural capital dependency post-revision, i.e., β_3 to be negative.

[Insert Table (5) here]

The results are shown in Panel A of Table (5). Column (1) implements Equation (2) without the loan-specific control variables. First, we obtain a positive and statistically significant positive coefficient on *Material Dependency* and a negative coefficient on *High Material Dependency* \times *After ESA*. This suggests that loan spreads on these highly dependent firms were positive before the amendment of the ESA. However, after the ESA amendment the spreads for these firms turned negative as compared to the other firms. This is consistent with lenders perceiving firms with higher nature dependency less risky. The point estimate in column (1) suggests that higher nature dependency firms are associated with 0.25% *lower* loan spreads after the ESA revision in the third quarter of 2019. Consistent with the evidence before, we do not find any systematic changes in the loan spreads for firms that are impacting natural ecosystems after the ESA amendment as shown by the point estimate on *Impact* \times *After ESA*.

[Insert Figure (1) here]

Additionally, Panel A in Figure (1) indicates no clear pattern in loan spreads in the quarters before the ESA revision, with loan spreads remaining consistently below zero in the periods following the revision, confirming that the observed changes occur after the ESA amendment.

The timing of this analysis raises some concerns. Specifically, we are using nature-related risk scores estimated at the end of 2022, while the regulatory change occurred in 2019. Firms may have adapted their business models in response to the new regulations, potentially impacting both their nature-related risk scores and loan spreads.

To assess if these adaptations influence our results, we calculate the change in firm scope from 2019 to 2021 using data from Hoberg and Phillips (2024). We then control for the change in loan spread due to shifts in firm scope. The findings, displayed in column (2) of the table, show that our results remain robust. The coefficient for *Scope Change* is statistically insignificant. However, we continue to obtain a statistically significant negative point estimate on *High Material Dependency*×*After ESA* in line with the previous results. Additionally, in Panel B of Figure 1, we show no marked difference in the loan spread dynamics if we additionally control for the change in loan spread associated with the change in firm scope. This suggests that the potential endogeneity related to loan spreads from changes in firm scope does not alter the inferences of our analysis.

3.2. Additional Validation Evidence

3.2.1. Other Lending Terms

We also explore the link between nature-dependency and other lending terms. Classical finance literature (e.g., Myers, 1977; Barclay and Smith, 1995; Stohs and Mauer, 1996) argues that loan maturity is closely related to the credit risk of borrowers. Higher-quality borrowers tend to receive longer loan maturities, while shorter-term loans are typically associated with higher-risk borrowers. Given this framework, firms with high nature-dependency may face shorter loan maturities, reflecting the higher perceived risk tied to their reliance on natural capital.

Additionally, firms with higher reliance on natural capital may face higher credit risk, leading banks to demand more collateral when lending to these firms. This would align with the tendency of banks to mitigate risk by securing loans with assets when lending to higher-risk borrowers. As a result, we might observe that firms with greater nature-dependency not only receive loans with shorter maturities but also obtain more secured loans, reflecting the heightened risks associated with their reliance on natural ecosystems and services.

[Insert Table (6) here]

Hence, in Table (6) we explore the association between nature-dependency and other loan terms like loan maturity and whether loans are secured. In column (1), we use the natural logarithm of loan maturity (in months) as the dependent variable. The coefficient on *Material Dependency* is negative and statistically significant, indicating that firms

with higher nature-dependency tend to receive loans with shorter maturities. Specifically, a 1% increase in nature-dependency corresponds to a 0.31% reduction in loan maturity.

In column (2), we examine whether loans are secured by including a binary variable that indicates if a loan is secured. The positive and statistically significant coefficient on *Material Dependency* suggests that firms with higher nature-dependency are more likely to obtain secured loans. A 1% increase in nature-dependency leads to a 26% higher likelihood of the loan being secured.

These results collectively support the conclusion that banks perceive firms more reliant on nature and its ecosystem services as riskier. Consequently, such firms are more likely to receive loans with shorter maturities and require collateral.

3.2.2. Alternative Measure of Nature Dependency

As discussed earlier, GRSW provide a valuable dataset on firms' nature-dependency. We use the GRSW measure for the syndicated loan sample from 2011 to 2022 to test whether we also find a positive relationship between nature-dependency and loan spreads using this alternative measure. The correlation between the GRSW and the S&P measures is 0.38. Therefore, if we observe a similar positive relationship between loan spreads and nature-dependency using the GRSW measure, it would further support our main results. We merge the GRSW measure with our sample firms based on the year before the loan contract. We then re-estimate our baseline model from equation (1), replacing our original nature-dependency scores with the GRSW measure.

[Insert Table (7) here]

The columns of Table (7) show results for the full sample period (2011–2022).⁷ In the last columns, we address missing nature-dependency observations in the syndicated loan sample by replacing them with the industry- and year-adjusted median GRSW nature-dependency score. We also include a dummy variable (*Missing Nature Dep GRSW*) to capture any association between loan spreads and this imputation. As shown in the table, the point estimates on the GRSW measure is consistently positive and statistically significant across all model specifications. This indicates that higher nature-dependency is also linked to higher loan spreads when using this alternative measure.

This analysis further highlights the robustness and generalizability of our main findings.

3.2.3. Heterogeneity among Ecosystem Services

Ecosystem services can be classified into three categories: regulating, provisioning, and supporting (Costanza et al., 1997). Based on research from The Economics of Ecosystems and Biodiversity (TEEB) initiative, the annual value of these services exceeds \$150 trillion, nearly twice global GDP (Kurth et al., 2021).

Regulating services account for roughly 60% of this value (Pascual et al., 2010). These include climate regulation through carbon sequestration, water purification, and disease control. Provisioning services represent about 7% of total value and include food, timber, and medicinal resources derived from natural ecosystems. Supporting services encompass habitat functions, soil formation, and cultural or recreational benefits such as tourism.

⁷We end the analysis in 2022 because the GRSW measure is not available beyond that year.

If banks assess nature-related exposures with any sophistication, their pricing should differ across categories. Regulating services cannot be purchased as commodities or easily substituted through technology, while provisioning services often have market alternatives. We construct category-specific dependency scores by averaging individual ecosystem services within each category, then substitute these for the overall dependency score in our baseline regression.

[Insert Table (8) here]

The results are documented in Table (8). In columns (1) through (3), we examine how dependency on each of the three ecosystem service categories (regulating, provisioning, and supporting) relates to loan spreads individually. In column (4), we include all three category-specific dependencies simultaneously. The consistent finding across all columns is that banks view firms highly dependent on regulating services as particularly risky. The coefficient on *Regulating Services* in column (4) implies that a 1% higher dependency on ecosystems providing regulating services is associated with 0.54% higher loan spreads.

This result suggests that banks identify and price exposure to ecosystem services that are difficult or impossible to substitute. Unlike provisioning services, where firms can switch suppliers or find market alternatives, regulating services represent inputs for which no technological or market substitutes exist.⁸ If water purification services collapse

⁸Provisioning services produce tangible commodities with price signals allowing firms to adjust. Timber can be sourced from alternative regions, food inputs procured from different suppliers, and wild fish replaced by aquaculture. Regulating services cannot be purchased as commodities. If water purification or flood control services deteriorate, firms must either invest in engineered substitutes at prohibitive cost or relocate entirely.

or local climate regulation deteriorates, firms cannot simply purchase these functions elsewhere.

This interpretation is consistent with how major banks operationalize environmental risk frameworks. Sector-specific guidelines under the Equator Principles and IFC Performance Standards typically prohibit financing in areas of high water stress, mandate enhanced due diligence for projects affecting water resources and habitat integrity, and exclude activities in or near protected areas and high conservation value forests. These guidelines focus precisely on the regulating services we identify as priced. That our empirical results align with the ecosystem services that banks explicitly screen in their due diligence suggests the pricing patterns we document reflect deliberate risk assessment rather than incidental correlation.

3.2.4. Nature-Dependency and Loan Spreads in Recent Years

If cross-sectional measurement induces spurious correlation, we would expect the relationship to weaken in recent years when nature-related risks have received greater attention. To address this concern, we repeat our baseline analysis, restricting the sample to loans issued after 2017 (i.e., 2018 onward). We then conduct the same analysis with a further restriction to loans issued after 2020.

[Insert Table (9) here]

The results of the analysis are presented in Table (9). Our findings remain robust and consistent, even when the sample is limited to loans issued after 2020 in columns (3) and

(4). This suggests that the relationship between nature-dependency and loan spreads persists in more recent years when natural capital considerations were likely stronger in financial markets.

These findings align with the broader literature (Giglio et al., 2023), which documents that concerns about environmental issues, including biodiversity and broader natural capital risks, have intensified in recent years. This consistency provides additional support for our argument that lenders are increasingly incorporating nature-related risks into their loan pricing.

3.3. Additional Robustness Tests

3.3.1. Controlling for ESG Ratings and Climate Change Exposure

One potential concern with the previous analyses is that banks may be reacting to a firm's overall environmental, social, and governance (ESG) ratings (e.g., as shown in Fabisik et al., 2023; Apergis et al., 2022) rather than directly to its nature-dependency risk. If ESG ratings capture broader environmental concerns, they could act as an omitted variable, potentially biasing the main results. To address this issue, we incorporate firms' ESG ratings into our analysis as an additional control.

We obtain the ESG scores from MSCI. We individually use the E, S, G, and the overall ESG score of a firm from MSCI. To address any changes in loan spreads potentially influenced by ESG factors, we incorporate these scores into our baseline regression model. By including the E, S, G, and overall ESG scores separately in our regression, we can distinguish the effects of nature-related measures from the broader ESG factors. This

helps test whether banks are specifically responding to risks related to nature-dependency and impact, rather than general environmental or governance concerns.

[Insert Table (10) here]

The results of this analysis are presented in Table (10). The coefficients on *Material Dependency* remain positive and statistically significant across all specifications. Moreover, the magnitude of these coefficients is at least as large as those in Table (4). This finding suggests that even after controlling for ESG scores, the effect of nature-dependency on loan spreads persists.⁹

It could also be that firms that have more climate change exposure are also more dependent on natural capital. Hence, our results could be biased if this is indeed the case. In order to investigate the robustness of the result to such concerns, we also include climate change exposure of firms in our sample. We obtain the data on climate change exposure of firms from Sautner et al. (2023)¹⁰. We use both the exposure and risk variables from their study and control for them in our baseline regression specification. In column (5) we present the result of this analysis. We continue to obtain qualitatively and quantitatively similar results.

The robustness of these results indicates that banks are directly pricing the risk associated with firms' dependence on natural capital, rather than merely responding to the firms' broader ESG ratings and climate change exposure. Thus, nature-dependency

⁹In unreported tables, we also obtain similar results if we instead control for the ESG rating of a firm (that ranges from AAA to C).

¹⁰We thank the authors for making their data available for further research.

poses a unique financial risk that banks take into account when determining loan terms, independent of other ESG considerations.

3.3.2. Excluding the COVID-19 Years

One possible concern is that our results might be influenced by the COVID-19 years. To address this, we re-run our baseline analysis excluding the years 2020 and 2021.

[Insert Table (11) here]

Table (11) presents the results of this analysis. Column (1) includes firm-level control variables, while column (2) also includes loan-level controls. In both columns, the coefficient on nature-dependency remains positive and statistically significant. This indicates that our main findings hold even when the COVID-19 years are excluded. Regarding the economic effect, the estimate of 0.49 in column (2) implies that a 1% increase in nature-dependency is associated with a 0.49% increase in loan spreads. This effect is slightly larger than the one reported in Table (4). Thus, if anything, excluding the COVID-19 years makes our baseline findings even stronger. This could be consistent with lenders focusing on other issues during COVID-19 rather than just nature-dependency of the borrowers.

3.3.3. Other Fixed Effects Structure

Our main analysis uses fixed effects based on calendar half-years. This approach ensures that our results are not driven by very few observations, which could occur with a stricter fixed-effects structure. However, in Table (A5) we demonstrate that the results remain

consistent even when using stricter calendar-quarter fixed effects. Additionally, in other unreported analyses, we confirm that all our findings are robust to this stricter fixed-effects approach.

4. Possible Mechanisms

We examine the role of refinancing risk. Firms with more short-term debt must refinance frequently, exposing them to changes in market conditions and lender risk assessments. Nature dependency compounds this exposure: if lenders become concerned about environmental or regulatory risks, they may demand higher rates or deny refinancing altogether. Denial can force inefficient liquidation or fire sales of assets (Diamond, 1991; Choi et al., 2021), generating losses for existing creditors.

In order to investigate this issue, we calculate the amount of *ex-ante* short term debt as a proportion of long term debt. We then identify firms in the highest tercile of this ratio as firms relying on more short term debt (*High St.Debt*). We then interact this variable with our main variables of interest in our baseline equation (1) to understand if firms with higher nature-dependency and higher short-term debt have higher loan spreads.

[Insert Table (12) here]

The results of the analysis are shown in Table (12). Columns (1) and (2) show the results of the subsample of observations belonging to firms with low and high short-term debt, respectively. The point estimates are positive in both subsamples. However, it is

only statistically significant in column (2), i.e., in the subsample of firms with a high proportion of short-term debt. This correlation is consistent with lenders perceiving nature-dependent borrowers as risky. Notably, our earlier results show that banks endogenously provide shorter loan maturities to nature-dependent firms, suggesting that banks both price and create refinancing exposure for these borrowers. In column (3), we find that the coefficient on the double interaction term, *Material Dependency*×*High St.Debt*, is positive and significant at the 1% level, implying that the point estimates in the two subsamples are different from each other.

The negative coefficient on *Impact*×*High St.Debt* is inconsistent with risk pricing (which requires a positive premium). We leave investigation of this pattern to future research.

5. Discussion on Double Materiality

From a standard finance perspective, this asymmetry is unsurprising. Banks price risks that affect borrowers' capacity to service debt. Dependency creates direct balance sheet exposure. If water supplies fail or pollination services collapse, nature-dependent firms face operational disruptions that impair cash flows and increase default probability. Impact, by contrast, generates costs that firms can largely externalize under current regulatory and liability regimes. A firm that degrades local ecosystems does not automatically bear the financial consequences of that degradation. Until legal frameworks evolve to internalize these externalities, the financial transmission from impact to credit risk remains attenuated, and banks have limited incentive to price it.

Several additional factors reinforce this asymmetry. Dependency is more readily measurable through input requirements and geographic exposure, while impact involves diffuse causal chains that current methodologies struggle to quantify at the firm level. The temporal structure also differs: dependency can crystallize rapidly when ecosystem services fail, whereas impact-related liabilities depend on future regulatory action, litigation outcomes, or shifts in consumer preferences. Impact risks may also be more systematic in nature. If regulatory regimes tighten to hold firms accountable for ecosystem damage, many firms could face liability simultaneously, making such risks difficult to diversify and therefore harder to price through standard credit analysis.

These findings carry implications for disclosure frameworks. The Task Force on Nature-related Financial Disclosures (TNFD) recommends reporting both dependencies and impacts because the two channels create distinct risk profiles. Our results provide empirical support for this approach: disclosure of dependency captures risks currently priced, while disclosure of impact remains essential for anticipating how pricing may evolve as liability frameworks develop. If banks systematically ignore impact-related risks, firms face weaker market-based incentives to mitigate their environmental footprint. This gap may accelerate ecosystem degradation that ultimately feeds back into the physical risks that banks do price, a feedback loop that current loan pricing does not anticipate.

6. Conclusion

Banks price firms' dependency on nature but not their impact on it. This asymmetry reflects distinct financial channels: dependency creates direct balance sheet exposure, while impact costs remain largely externalized. The concentration of pricing in non-substitutable regulating services suggests banks distinguish between manageable supply chain risks and fundamental operational vulnerabilities.

Market forces alone are therefore unlikely to redirect capital away from nature-degrading activities. If banks price only risks that firms bear directly, ecosystem degradation may continue unpriced until regulatory frameworks internalize these externalities. Policy interventions through disclosure requirements, liability rules, or direct regulation may be necessary to align private lending incentives with environmental objectives.

Our results also illuminate the debate on double materiality. Firms face financial risks from their dependency on nature (outside-in) and create risks for nature through their operations (inside-out). Credit markets respond to the first channel but not the second. This selective pricing suggests that double materiality, while conceptually coherent, does not translate into symmetric market responses absent regulatory pressure on the impact dimension.

Nature dependency may also generate systematic risks that current pricing fails to capture. Water scarcity, pollinator decline, or soil degradation could disrupt multiple sectors simultaneously in ways that are difficult to diversify. If such correlated shocks materialize, the modest risk premia we document may prove inadequate. Whether finan-

cial markets can accurately price the systematic component of nature-related risks, given that individual banks lack incentives to internalize economy-wide correlations, remains an open question.

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Table 1 – Summary Statistics

This table shows the summary statistics. The sample goes from 2016 to 2023. Variable description is provided in the appendix A1.

Variable	N	Mean	SD	p5	Median	p95
Spread(bps)	1,708	191.37	129.86	75.00	150.00	460.00
Loan Size(mil)	1,708	1228.67	1687.67	60.00	600.00	4411.00
Loan Term(mo)	1,708	49.47	22.41	12.00	60.00	84.00
Callable	1,708	0.10	0.29	0.00	0.00	1.00
Secured	1,708	0.28	0.45	0.00	0.00	1.00
Impact	1,708	4.08	2.45	0.74	3.65	9.22
Material Dependency	1,708	0.36	0.18	0.03	0.40	0.57
Materiality: Regulating Services	1,708	0.12	0.09	0.00	0.11	0.26
Materiality: Provisioning Servic	1,708	0.07	0.09	0.00	0.03	0.29
Materiality: Supporting Services	1,708	0.06	0.08	0.00	0.01	0.26
Firm Maturity	1,708	0.23	0.52	-0.59	0.26	0.96
Leverage	1,708	0.31	0.18	0.01	0.29	0.66
MTB	1,708	4.74	13.65	-2.64	2.76	16.78
Profitability	1,708	0.12	0.14	-0.07	0.11	0.37
St.Dev.(Profitability)	1,708	0.23	6.68	0.01	0.03	0.19
Sales Growth	1,708	9.53	26.59	-21.46	5.54	51.89
Size	1,708	8.64	1.73	5.87	8.67	11.44
Tangibility	1,708	0.24	0.22	0.03	0.16	0.74
Z-Score	1,708	3.02	3.43	0.30	2.14	8.18

Table 2 – Industry Heterogeneity

This table presents summary statistics based on industry classifications. Panel A reports the distribution of observations across different industries using the Fama-French 12 classification (for brevity). Panels B and C adopt the more granular Fama-French 48 industry classification. Panel B identifies the five industries with the highest average material dependency on nature among firms in our sample, while Panel C highlights the five industries with the greatest average impact on nature.

Panel A: Number of Observations by Industry

Industry	N
Consumer Non-Durables	156
Consumer Durables	51
Manufacturing	261
Energy	81
Chemicals	93
Business Equipment & Software	360
Telecommunication	57
Wholesale & Retail	214
Healthcare	197
Other	238
Total	1,708

Panel B: List of Top 5 Industries, Average Dependency

Industry	Average Dependency
Agriculture	0.593
Candy & Soda	0.577
Beer & Liquor	0.576
Petroleum and Natural Gas	0.569
Coal	0.561

Panel C: List of Top 5 Industries, Average Impact

Industry	Average Impact
Agriculture	13.479
Petroleum and Natural Gas	8.141
Non-Metallic and Industrial Metal Mining	7.729
Coal	7.193
Transportation	6.436

Table 3 – Correlation of Nature-Related Measures to ESG Scores

This table presents the correlation between Nature-dependency and impact and the MSCI E, S, G, and the overall ESG scores for firms in our sample.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Impact	1.00					
(2) Material Dependency	0.15	1.00				
(3) MSCI E-Score	0.06	-0.31	1.00			
(4) MSCI S-Score	-0.08	-0.01	0.05	1.00		
(5) MSCI G-Score	0.05	-0.09	-0.10	0.02	1.00	
(6) MSCI ESG-Score	0.06	-0.12	0.23	0.51	0.41	1.00

Table 4 – Nature Dependency and Loan Spread

This table investigates whether nature dependency and impact is associated with loan spreads. The dependent variable is the natural logarithm of the loan spreads. The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). The sample population includes 1,708 loans from years 2016 through 2023 that were made to 662 distinct publicly traded U.S. firms. Financial (SIC 6000 – 6999) and utility (SIC 4900–4949) firms are excluded from the sample. Fixed effects for industry (FFI48) and time are included as indicated. Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. We cluster standard errors at the firm level and lender level. t-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = Spread			
	(1)	(2)	(3)	(4)
<i>Material Dependency</i>	0.3584*** (10.22)	0.2850*** (8.65)	0.2674*** (5.55)	0.3231*** (3.92)
<i>Impact</i>	0.0067 (0.95)	0.0044 (0.67)	0.0080 (1.55)	0.0092 (1.14)
Leverage	0.4689*** (8.21)	0.3784*** (7.01)	0.3516*** (4.53)	0.2219*** (4.34)
Size	-0.1195*** (-8.64)	-0.0897*** (-5.37)	-0.0932*** (-7.08)	-0.0887*** (-8.50)
Profitability	-0.5204*** (-8.45)	-0.4355*** (-6.29)	-0.3253*** (-2.91)	-0.3026* (-1.90)
Tangibility	0.1798** (2.43)	0.1687*** (2.85)	0.1423*** (2.88)	0.0557 (0.59)
Sales Growth	0.0007*** (2.95)	0.0006*** (3.34)	-0.0005 (-1.64)	-0.0005 (-1.25)
Z-Score	-0.0161*** (-4.57)	-0.0141*** (-4.23)	-0.0132*** (-2.72)	-0.0175*** (-4.74)
Firm Maturity	-0.1034*** (-3.34)	-0.0673** (-2.64)	-0.0886*** (-3.34)	-0.0943*** (-2.91)
MTB	-0.0021*** (-3.71)	-0.0018*** (-3.51)	-0.0006 (-1.03)	0.0005 (1.30)
Analyst	-0.0819*** (-2.96)	-0.0555* (-1.78)	-0.0633** (-2.66)	-0.1017*** (-3.25)
St.Dev.(Profitability)	0.0009 (1.63)	0.0010** (2.18)	0.2004*** (5.54)	0.2736*** (7.98)
Callable		0.4111*** (6.88)	0.4133*** (9.85)	0.3863*** (13.17)
Secured		0.1809*** (4.43)	0.1463** (2.63)	0.1112* (1.96)
Loan Term		0.0036 (0.15)	-0.0043 (-0.27)	-0.0194 (-1.31)
Loan Size		-0.0258 (-1.49)	-0.0360** (-2.35)	-0.0261*** (-4.30)
Loan Purpose FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes		
Industry FE	Yes	Yes		
Lender Parent FE	Yes	Yes		
Time × Industry FE			Yes	
Time × Lender FE			Yes	
Time × Lender × Industry FE				Yes
Observations	1,708	1,700	1,559	1,229
Adjusted R-squared	0.5751	0.6535	0.7248	0.8017

Table 5 – Nature Dependency and Loan Spread around the Endangered Species Act, 2019

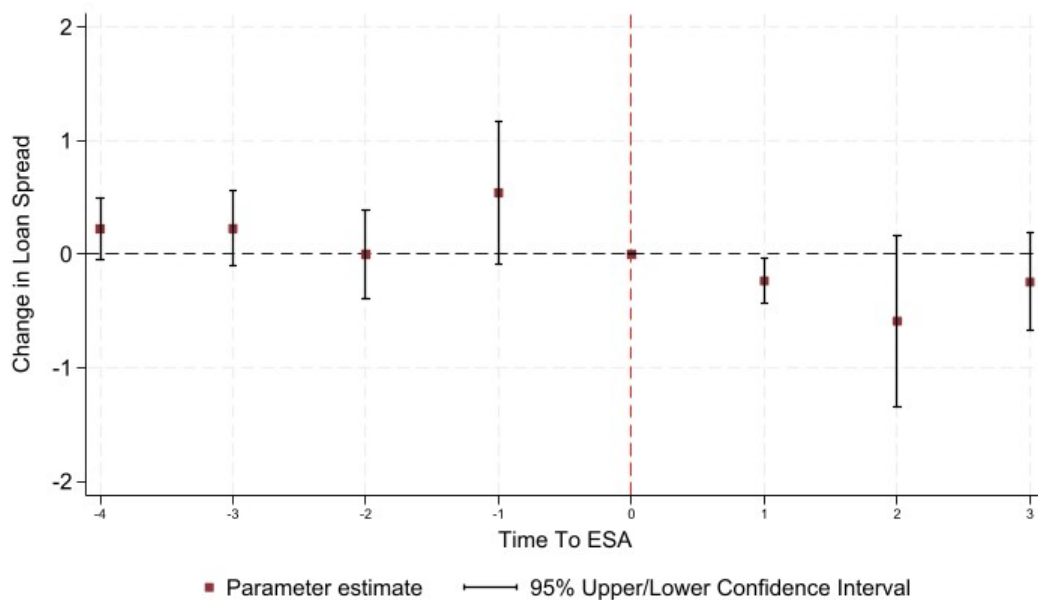
This table investigates whether nature-dependency and impact is associated with a lower spreads after the amendment Endangered Species Act in the third quarter of 2019. The dependent variable is the natural logarithm of the loan spreads. *High Material Dependency* is a dummy variable that takes the value of 1 for firms with greater than median average score of nature-dependency for the ecosystem services that are most likely to be related to protected areas and/or key biodiversity areas. The sample is six quarters before and after the amendment of the act. The dummy variable *After ESA* takes the value of 1 for the quarters after the passage of the law. Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and the lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = Spread	
	(1)	(2)
High Material Dependency	0.1535*	0.1598*
	(2.04)	(2.06)
After ESA	0.0907	0.0797
	(0.92)	(0.79)
High Material Dependency × After ESA	-0.2497**	-0.3018**
	(-2.27)	(-2.43)
Impact	0.0076	0.0116
	(0.53)	(0.69)
Impact × After ESA	-0.0008	0.0082
	(-0.05)	(0.47)
Scope Change		-0.0031
		(-0.10)
Controls	Yes	Yes
Loan Purpose FE	Yes	Yes
Time × Lender × Industry FE	Yes	Yes
Observations	509	491
Adjusted R-squared	0.84	0.85

Figure 1 – Loan Spreads around the Endangered Species Act Amendment of 2019

This figure shows the point estimates for the regression model in Table (5)- loan spreads on nature-dependency around the Endangered Species Act of August 2019 ($t = 0$). The sample population includes loans from 2018 to 2021. Financial (SIC 6000 – 6999) and utility (SIC 4900–4949) firms are excluded from the sample. Panel A shows how loan spreads change based on material dependency of firms on nature controlling for their material impact. Panel B additionally controls for the change in scope of firms between 2019 and 2021 using data from Hoberg and Phillips (2024).

Panel A



Panel B

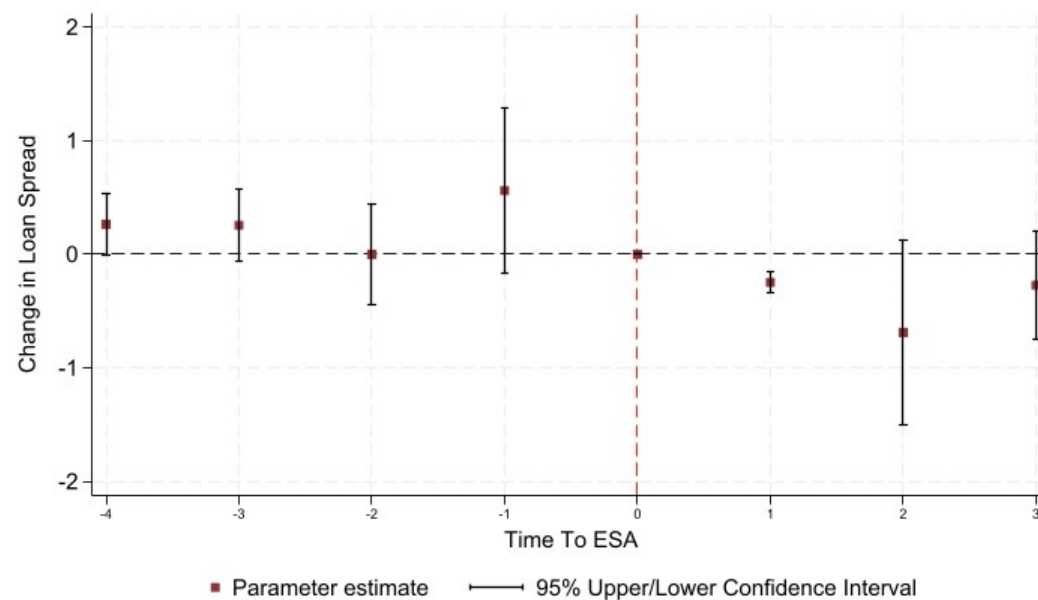


Table 6 – Nature Dependency and Other Lending Terms

This table presents the relationship between nature-dependency and other loan terms – a dummy variable indicating whether a loan is secured or not (SECURE), in column (1) and loan maturity (LOAN TERM), measured as the natural logarithm of loan maturity in number of months, in column (2). The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable	
	= LOAN TERM (1)	= SECURE (2)
Material Dependency	-0.3141*** (-3.38)	0.2556* (1.70)
Impact	-0.0127 (-0.83)	0.0033 (0.28)
Leverage	-0.2211 (-1.27)	0.2449 (1.31)
Size	-0.1261*** (-4.14)	-0.0016 (-0.14)
Profitability	-0.1038 (-0.43)	-0.1154 (-0.49)
Tangibility	-0.1536 (-0.53)	0.2461 (1.45)
Sales Growth	0.0005 (0.40)	-0.0009* (-1.78)
Z-Score	0.0113 (1.57)	-0.0015 (-0.21)
Firm Maturity	-0.0062 (-0.16)	-0.0552 (-1.04)
MTB	0.0003 (0.18)	-0.0004 (-0.28)
Analyst	0.0270 (0.62)	-0.1113*** (-8.18)
St.Dev.(Profitability)	-0.1145 (-0.98)	0.1322 (1.60)
Callable	0.4103*** (5.43)	0.4122*** (24.21)
Secured	0.3589*** (5.39)	
Loan Size	0.0244 (1.35)	-0.0205*** (-3.45)
Loan Term		0.0982*** (2.92)
Loan Purpose FE	Yes	Yes
Time × Lender × Industry FE	Yes	Yes
Observations	1,229	1,229
Adjusted R-squared	0.48	0.68

Table 7 – GRSW Measure of Nature Dependency and Loan Spread

This table presents the results for estimating our baseline specification in equation (1) by using the nature-dependency scores of Garel et al. (2025) (*Nature_Dep_GRSW*). Columns (1) and (2) span the sample period 2011–2022. Please refer the Table (A2) in the Appendix of the paper for variable definitions of other variables. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

VARIABLES	Dependent Variable = SPREAD	
	(1)	(2)
Nature_Dep_GRSW	0.2994** (2.06)	0.5129** (2.35)
Leverage	0.2485** (2.62)	0.3021*** (3.54)
Size	-0.0785*** (-5.14)	-0.0958*** (-12.58)
Profitability	-0.1765 (-0.58)	-0.3306** (-2.15)
Tangibility	0.2798*** (5.49)	0.0602 (0.61)
Sales Growth	0.0003 (0.24)	-0.0008 (-1.14)
Z-Score	-0.0340*** (-6.00)	-0.0145*** (-3.06)
Firm Maturity	-0.0759*** (-3.85)	-0.1082*** (-5.59)
MTB	-0.0009 (-1.63)	-0.0008 (-1.39)
Analyst	-0.0978*** (-9.03)	-0.0777*** (-4.75)
St.Dev.(Profitability)	-0.0791 (-0.26)	0.2286*** (6.40)
Callable	0.2893*** (8.45)	0.3348*** (11.26)
Secured	0.0806* (1.90)	0.1256*** (3.40)
Loan Term	-0.0179 (-1.02)	-0.0389** (-2.03)
Loan Size	-0.0096 (-1.15)	-0.0144*** (-3.10)
Missing Nature_Dep_GRSW		-0.0145 (-0.16)
Loan Purpose FE	Yes	Yes
Time × Lender × Industry FE	Yes	Yes
Observations	1,503	2,058
Adjusted R-squared	0.82	0.79

Table 8 – Ecosystem Services and Loan Spreads

This table investigates how dependency of different types of ecosystem services are priced in the syndicated loan market. The dependent variable is the natural logarithm of the loan spreads (*SPREAD*). The main variables of interest are the dependency on the categories of ecosystem services. These ecosystem services are Regulating Services, Provisioning Services, and Supporting Services. Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = SPREAD			
	(1)	(2)	(3)	(4)
Material Dependency: Regulating Services	0.6248** (2.60)			0.5394** (2.26)
Material Dependency: Provisioning Services		0.3552 (1.56)		0.0918 (0.38)
Material Dependency: Supporting Services			0.3163 (0.84)	0.1448 (0.40)
Impact	0.0072 (0.88)	0.0069 (0.93)	0.0082 (0.94)	0.0080 (0.87)
Leverage	0.2309*** (4.87)	0.2387*** (4.55)	0.2258*** (4.42)	0.2338*** (4.25)
Size	-0.0858*** (-8.50)	-0.0841*** (-8.80)	-0.0863*** (-8.62)	-0.0863*** (-8.35)
Profitability	-0.2936* (-1.93)	-0.2927* (-1.88)	-0.2789* (-1.80)	-0.2898* (-1.92)
Tangibility	0.0611 (0.64)	0.0447 (0.48)	0.0864 (0.80)	0.0610 (0.57)
Sales Growth	-0.0006 (-1.36)	-0.0006 (-1.35)	-0.0006 (-1.36)	-0.0006 (-1.34)
Z-Score	-0.0171*** (-4.49)	-0.0172*** (-4.17)	-0.0171*** (-4.18)	-0.0171*** (-4.37)
Firm Maturity	-0.0959*** (-3.27)	-0.0947*** (-3.25)	-0.0927*** (-3.09)	-0.0950*** (-3.15)
MTB	0.0006 (1.62)	0.0007** (2.12)	0.0006 (1.62)	0.0006* (1.77)
Analyst	-0.1029*** (-3.38)	-0.1019*** (-3.45)	-0.1003*** (-3.48)	-0.1026*** (-3.45)
St.Dev.(Profitability)	0.2634*** (7.11)	0.2468*** (6.45)	0.2455*** (5.56)	0.2628*** (6.65)
Callable	0.3864*** (12.96)	0.3892*** (12.50)	0.3880*** (11.73)	0.3862*** (12.54)
Secured	0.1141** (2.07)	0.1154** (2.11)	0.1211** (2.34)	0.1139** (2.13)
Loan Term	-0.0204 (-1.38)	-0.0242 (-1.56)	-0.0218 (-1.42)	-0.0208 (-1.30)
Loan Size	-0.0252*** (-4.39)	-0.0259*** (-4.69)	-0.0259*** (-4.41)	-0.0256*** (-4.28)
Loan Purpose FE	Yes	Yes	Yes	Yes
Time × Lender × Industry FE	Yes	Yes	Yes	Yes
Observations	1,229	1,229	1,229	1,229
Adjusted R-squared	0.80	0.80	0.80	0.80

Table 9 – Nature Dependency and Loan Spread in Recent Years

This table investigates whether there is any association between nature-dependency and impact and the loan spreads over the recent years. Columns (1) and (2) present results for the sample restricted to the period from 2018 to 2023, while Columns (3) and (4) narrow the sample to the period from 2021 to 2023. The dependent variable is the natural logarithm of the loan spreads (*SPREAD*). The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = SPREAD			
	Sample 2018-2023		Sample 2021-2023	
	(1)	(2)	(3)	(4)
<i>Material Dependency</i>	0.2393** (2.72)	0.1332** (2.18)	0.4900*** (5.71)	0.3491*** (3.42)
<i>Impact</i>	0.0127 (0.71)	0.0110 (0.68)	0.0111 (0.35)	0.0078 (0.26)
Leverage	0.4295*** (4.00)	0.3444*** (3.24)	0.3484** (2.58)	0.2930** (2.65)
Size	-0.1169*** (-4.36)	-0.1141*** (-7.05)	-0.1350*** (-4.05)	-0.1284*** (-4.61)
Profitability	-0.5038*** (-3.25)	-0.2571* (-1.90)	-0.2860* (-1.71)	0.0083 (0.06)
Tangibility	-0.1059 (-1.04)	-0.1451 (-0.92)	-0.1864 (-0.89)	-0.1738 (-0.67)
Sales Growth	-0.0011 (-1.56)	-0.0010 (-1.55)	-0.0015 (-1.27)	-0.0012 (-1.10)
Z-Score	-0.0176** (-2.39)	-0.0196*** (-3.39)	-0.0163** (-2.10)	-0.0190*** (-2.93)
Firm Maturity	-0.0527** (-2.13)	-0.0727*** (-2.89)	-0.0333* (-1.85)	-0.0617*** (-3.38)
MTB	-0.0004 (-0.29)	-0.0006 (-0.68)	-0.0006 (-0.37)	-0.0008 (-0.68)
Analyst	-0.1264*** (-3.38)	-0.0740 (-1.31)	-0.1221** (-2.78)	-0.0726 (-1.35)
St.Dev.(Profitability)	0.2348 (1.33)	0.3773* (2.00)	0.3225 (1.55)	0.4494** (2.16)
Callable		0.4319*** (5.46)		0.4230*** (5.68)
Secured		0.1256 (1.33)		0.0706 (1.07)
Loan Term		-0.0261 (-1.18)		-0.0110 (-0.49)
Loan Size		-0.0117 (-1.67)		-0.0064 (-0.68)
Loan Purpose FE	Yes	Yes	Yes	Yes
Time × Lender × Industry FE	Yes	Yes	Yes	Yes
Observations	561	561	441	441
Adjusted R-squared	0.7670	0.8111	0.7772	0.8170

Table 10 – Nature Dependency, Loan Spreads, ESG Characteristics

This table investigates if the results are robust to controlling for ESG scores of firms. The dependent variable is the natural logarithm of the loan spreads (*SPREAD*). The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). We control for the E,S,G, and the overall ESG score of firms in columns (1) - (4) respectively. In addition, in column (5), we control for climate change exposure and risk of firms as measured by Sautner et al. (2023). Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = Spread				
	(1)	(2)	(3)	(4)	(5)
<i>Material Dependency</i>	0.3236*** (3.86)	0.3517*** (4.74)	0.3522*** (3.99)	0.3549*** (4.44)	0.3476*** (3.59)
<i>Impact</i>	0.0131 (0.98)	0.0113 (0.85)	0.0123 (0.97)	0.0107 (0.82)	0.0104 (0.83)
MSCI E-Score	-0.0179 (-1.33)				
MSCI S-Score		0.0056 (0.39)			
MSCI G-Score			-0.0210 (-1.36)		
MSCI ESG-Score				-0.0015 (-0.17)	-0.0020 (-0.23)
Climate Change Exposure					-0.4154 (-0.03)
Climate Change Risk					87.225 (0.47)
Leverage	0.2116*** (3.20)	0.1915** (2.70)	0.1797*** (3.15)	0.1877*** (2.82)	0.1911 (2.76)
Size	-0.0736*** (-4.57)	-0.0865*** (-5.21)	-0.0867*** (-5.66)	-0.0857*** (-5.32)	-0.0852*** (-5.35)
Profitability	-0.2807 (-1.16)	-0.2831 (-1.24)	-0.2790 (-1.25)	-0.2841 (-1.23)	-2.2853 (-1.23)
Tangibility	-0.0275 (-0.16)	0.0160 (0.10)	-0.0004 (-0.00)	0.0113 (0.07)	0.0120 (0.08)
Sales Growth	-0.0005 (-1.37)	-0.0005 (-1.52)	-0.0004 (-1.02)	-0.0005 (-1.48)	-0.0004 (-1.44)
Z-Score	-0.0164*** (-4.77)	-0.0166*** (-5.11)	-0.0170*** (-4.06)	-0.0168*** (-4.73)	-0.0166*** (-3.89)
Firm Maturity	-0.1026*** (-3.02)	-0.0999*** (-2.93)	-0.0960** (-2.44)	-0.0981*** (-2.82)	-0.0981*** (-2.67)
MTB	0.0001 (0.13)	0.0001 (0.05)	0.0002 (0.17)	0.0001 (0.09)	0.0001 (0.09)
Analyst	-0.1072*** (-3.27)	-0.1032*** (-3.06)	-0.1051*** (-3.32)	-0.1026*** (-3.12)	-0.1024*** (-3.16)
St.Dev.(Profitability)	0.2834*** (6.23)	0.2663*** (7.40)	0.2704*** (9.51)	0.2699*** (7.80)	0.2681*** (8.01)
Callable	0.3531*** (12.73)	0.3521*** (12.39)	0.3523*** (11.87)	0.3522*** (11.41)	0.3518*** (12.71)
Secured	0.1099** (2.19)	0.1150** (2.24)	0.1162** (2.32)	0.1168** (2.28)	0.1179** (2.35)
Loan Term	-0.0108 (-0.68)	-0.0112 (-0.73)	-0.0095 (-0.61)	-0.0113 (-0.73)	-0.0113 (-0.73)
Loan Size	-0.0258*** (-4.87)	-0.0246*** (-4.59)	-0.0251*** (-4.76)	-0.0246*** (-4.49)	-0.0248*** (-4.23)
Loan Purpose FE	Yes	Yes	Yes	Yes	Yes
Time × Lender × Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	1,131	1,131	1,131	1,131	1,129
Adjusted R-squared	0.7944	0.7931	0.7938	0.7930	0.7921

Table 11 – Nature Dependency and Loan Spread Without COVID Years

This table investigates whether there is any association between nature-dependency and impact and the loan spreads without the COVID years 2020 and 2021 . Columns (1) and (2) present the results. The dependent variable is the natural logarithm of the loan spreads (*SPREAD*). The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

VARIABLES	Dependent Variable = SPREAD	
	(1)	(2)
Material Dependency	0.5854*** (4.61)	0.4882*** (4.24)
Impact	0.0152 (1.54)	0.0067 (0.57)
Leverage	0.1590 (1.55)	0.0872 (1.41)
Size	-0.0941*** (-7.02)	-0.0763*** (-8.66)
Profitability	-0.2489* (-1.78)	-0.1737 (-1.22)
Tangibility	0.2904** (2.61)	0.1074 (1.03)
Sales Growth	-0.0012** (-2.59)	-0.0004 (-0.92)
Z-Score	-0.0179** (-2.13)	-0.0179*** (-2.84)
Firm Maturity	-0.1445** (-2.73)	-0.1334*** (-2.76)
MTB	0.0019* (1.80)	0.0014 (1.29)
Analyst	-0.1575*** (-8.62)	-0.1140*** (-6.27)
St.Dev.(Profitability)	0.3708*** (7.46)	0.2832*** (5.98)
Callable		0.3846*** (9.08)
Secured		0.0857 (1.56)
Loan Term		-0.0163 (-1.23)
Loan Size		-0.0288*** (-2.80)
Loan Purpose FE	Yes	Yes
Time × Lender × Industry FE	Yes	Yes
Observations	917	917
Adjusted R-squared	0.73	0.78

Table 12 – Nature Dependency, Loan Spread, and Short-term Debt

This table investigates whether the relationship between nature-dependency and impact is moderated by the short-term to long-term debt ratio of firms. Firms with their short-term debt ratio in the highest tercile in a given time period are considered as high short-term debt (*High St. Debt*) firms. The dependent variable is the natural logarithm of the loan spreads (*SPREAD*). The main variables of interest are the double interaction term between nature-dependency (*Material Dependency*) and *High St. Debt* (*Material Dependency* \times *High St. Debt*) as well as the interaction term, *Impact* \times *High St. Debt*. Please refer the Table (A2) in the Appendix of the paper for detailed variable definitions. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and lender level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = SPREAD		
	(1)	(2)	(3)
Material Dependency	0.2255 (1.33)	1.4847*** (10.12)	0.2255 (1.32)
Material Dependency x High St. Debt			1.2592*** (6.17)
Impact	0.0127* (1.71)	-0.0414** (-2.85)	0.0127 (1.67)
Impact x High St. Debt			-0.0541*** (-3.11)
Sample Restrictions	High St. Debt = 0	High St. Debt = 1	
Controls	Yes	Yes	Yes
Loan Purpose FE	Yes	Yes	Yes
Time \times Lender \times Industry FE	Yes	Yes	Yes
Observations	688	302	990
Adjusted R-squared	0.85	0.86	0.86

Appendix

Table A1 – Within-Firm Correlation of GRSW Nature Dependency Scores

This table shows how a firm’s nature-dependency score calculated by Garel et al. (2025) (GRSW) correlates with its own past values at different time lags. The number after L indicates the number of years of lag. For example, $L1$ *Nature_Dep_GRSW* refers to the correlation with the one-year lagged value, and $L5$ *Nature_Dep_GRSW* refers to the correlation with the five-year lagged value. Panel A reports the correlations for all U.S. firms in the GRSW sample. Panel B shows the same correlations for the subset of firms included in our analysis.

Panel A: All US Firms

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Nature_Dep_GRSW	1.000					
(2) L1 Nature_Dep_GRSW	0.976	1.000				
(3) L2 Nature_Dep_GRSW	0.955	0.974	1.000			
(4) L3 Nature_Dep_GRSW	0.936	0.953	0.973	1.000		
(5) L4 Nature_Dep_GRSW	0.916	0.932	0.951	0.974	1.000	
(6) L5 Nature_Dep_GRSW	0.899	0.913	0.931	0.953	0.975	1.000

Panel B: Firms in our Sample

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Nature_Dep_GRSW	1					
(2) L1 Nature_Dep_GRSW	0.980	1				
(3) L2 Nature_Dep_GRSW	0.961	0.979	1			
(4) L3 Nature_Dep_GRSW	0.941	0.958	0.977	1		
(5) L4 Nature_Dep_GRSW	0.922	0.938	0.956	0.977	1	
(6) L5 Nature_Dep_GRSW	0.906	0.921	0.938	0.959	0.979	1

Table A2 – Variable Definitions

This table presents the definition of the main variables used in the paper. We also provide the source of the data and the respective variable name in the database concerned

Variables	Definition and Measurement
Loan characteristics	
<i>Spread</i>	The natural logarithm of the “all-in-drawn” lending spread (bps) as reported (ALL_IN_SPREAD_DRAWN_BPS). Where specifically noted, we report this variable unlogged in terms of basis points (bps) for descriptive purposes. <i>Source: LoanConnector.</i>
<i>Loan Term</i>	The natural logarithm of loan maturity measured in months. Where specifically noted, we report this variable in terms of months for descriptive purposes.(TENOR_MATURITY) <i>Source: LoanConnector.</i>
<i>Loan Size</i>	Natural logarithm of the amount of a loan in millions of dollars. (TRANCHE_AMOUNT)
<i>Secured</i>	Indicator variable equal to one if a loan is secured, and zero otherwise. (SECURE_D) <i>Source: LoanConnector.</i>
<i>Loan Purpose</i>	The loan purpose(PRIMARY_PURPOSE). <i>Source: LoanConnector.</i>
<i>Callable</i>	Indicator variable equal to one if a loan has a call protection, and zero otherwise.(CALL_PROTECTION) <i>Source: LoanConnector.</i>
Firm and other characteristics	
<i>Size</i>	The natural logarithm of total assets (ITEM2999). Where specifically noted, we report this variable in millions for descriptive purposes.
<i>MTB</i>	The market value of equity (ITEM7210) scaled by book value of equity (ITEM3501).
<i>Leverage</i>	Total long-term debt (ITEM3255) scaled by total assets (ITEM2999).
<i>Tangibility</i>	Net property, plant, and equipment (ITEM2501) divided by total assets (ITEM2999).
<i>Z-Score</i>	Calculated as $1.2 \times ((\text{ITEM2201} - \text{ITEM3101}) / \text{ITEM2999}) + 1.4 \times (\text{ITEM3495} / \text{ITEM2999}) + 3.3 \times (\text{ITEM1551} / \text{ITEM2999}) + 0.6 \times ((\text{ITEM7210}) / \text{ITEM3351}) + 0.999 \times (\text{ITEM1001} / \text{ITEM2999})$.
<i>Profitability</i>	The ratio of operating income (ITEM1250) scaled by sales (ITEM1001).
<i>St.Dev.(Profitability)</i>	The standard deviation of profitability over the previous 8 quarters.
<i>Analyst</i>	The natural logarithm of the number of unique analysts issuing a forecast for the next year per I\B\E\S database. <i>Source: I\B\E\S.</i>
<i>Sales Growth</i>	Sales growth, measures as (ITEM8698)
<i>Firm Maturity</i>	Retained earnings (ITEM3495) divided by total assets (ITEM2999).
<i>Lender Parent</i>	The lender parent (LENDER_PARENT_ID). <i>Source: LoanConnector.</i>

Table A3 – Ecosystems List Relevant for Protected Areas and/or Key Biodiversity Areas

This table presents the different ecosystem services (*Ecosystem Services Names*) that is used by S&P Sustainable1 that are most likely related to Protected Areas (PAs) and/or Key Biodiversity Areas as compared to other services. We use Watson et al. (2014) for this classification. In column (2) we provide a brief note on the rationale for including an ecosystem service and refer to the relevant part of Watson et al. (2014).

Ecosystem Service Names	Supporting Evidence from Watson et al. (2014)
Bio Remediation	Protected areas help maintain ecosystem functions that naturally degrade pollutants (p. 68).
Buffering & Attenuation of Mass Flows	PAs reduce environmental degradation and buffer ecological processes, supporting flow stability (p. 68–69).
Climate Regulation	PAs support carbon storage in forests and peatlands, contributing to climate mitigation (p. 68).
Disease Control	Intact ecosystems in PAs regulate species interactions, indirectly reducing disease risks (p. 68-70).
Filtration	One-third of the world’s largest cities rely on PAs for clean drinking water, evidencing filtration services (p. 68–69).
Flood and Storm Protection	Ecosystem integrity in PAs, including coastal vegetation, helps reduce flood and storm damage (p. 68-70).
Ground Water	PAs protect watersheds essential for groundwater recharge (p. 68).
Maintain Nursery Habitats	Fish stock protection in PAs implies conservation of critical nursery habitats (p. 68).
Mass Stabilization & Erosion Control	Vegetation in PAs stabilizes soils and prevents erosion, especially on slopes and coasts (p. 68-70).
Pest Control	While not directly emphasized, maintaining biodiversity and intact food webs within protected areas indirectly controls pests through natural predator-prey dynamics (p. 68-70).
Pollination	Conserving wild species and biodiversity directly supports pollination services, although pollination is not individually emphasized, the maintenance of ecological functions covers it (p. 68-70).
Soil Quality	PAs preserve soil formation processes and protect against degradation (p. 68).
Surface Water	PAs contribute to high-quality surface water supplies for human use (p. 68).
Water Flow Maintenance	PAs help sustain hydrological cycles essential for water flow (p. 68–69).
Water Quality	Clean water provision is a key service of protected catchments and forests (p. 68).

Table A4 – Ecosystems List and Categories

This table presents the different ecosystem services (*Ecosystem Services Names*) that is used by S&P Sustainable1 to calculate their measure of nature dependency and impact. Additionally, we also categorize these ecosystem services into three categories, namely, *regulating*, *provisioning*, and *support* services

Ecosystem Categories	Ecosystem Services Names
<i>Regulating Services</i>	Bioremediation, Regulation of Climatic Conditions, Disease Control, Filtration, Flood and Storm Protection, Ground and Surface Water, Maintaining Nursery Habitats, Mass Stabilisation & Erosion Control, Pest Control, Pollination Services, Soil Quality, Water Flow Maintenance, Water Quality <i>Source: S&P Sustainable1.</i>
<i>Provisioning Services</i>	Fibres & Other Materials, Genetic Materials, Surface Water <i>Source: S&P Sustainable1.</i>
<i>Support Services</i>	Buffering & Attenuation of Mass Flows, Dilution by Atmosphere and Ecosystems, Mediation of Sensory Impacts, Ventilation <i>Source: S&P Sustainable1.</i>

Table A5 – Nature Dependency and Loan Spread, Other Fixed Effects Structure

This table investigates whether nature dependency and impact is associated with loan spreads. The dependent variable is the natural logarithm of the loan spreads. The main variables of interest are nature-dependency (*Material Dependency*) and impact (*Impact*). The sample population includes 2,968 loans from fiscal years 2011 through 2023 that were made to 866 distinct publicly traded U.S. firms. Financial (SIC 6000 – 6999) and utility (SIC 4900–4949) firms are excluded from the sample. Fixed effects for industry (FFI48) and time are included as indicated. Time fixed effects are *calendar quarter*. See the Appendix table (A2) to the paper for detailed variable definitions. We cluster standard errors at the firm level and lender level. t-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

Variables	Dependent Variable = SPREAD			
	(1)	(2)	(3)	(4)
<i>Material Dependency</i>	0.3498*** (9.69)	0.2836*** (8.35)	0.2550*** (3.50)	0.3074* (1.73)
<i>Impact</i>	0.0066 (0.98)	0.0045 (0.75)	0.0161* (1.80)	0.0136 (1.07)
Leverage	0.4668*** (8.10)	0.3868*** (6.91)	0.3118*** (3.57)	0.2750*** (3.42)
Size	-0.1251*** (-10.37)	-0.0930*** (-5.72)	-0.1112*** (-6.40)	-0.1100*** (-4.73)
Profitability	-0.4980*** (-7.46)	-0.4266*** (-5.83)	-0.3356** (-2.22)	-0.2700 (-1.10)
Tangibility	0.1993*** (2.71)	0.1886*** (3.30)	0.1404 (1.38)	-0.0555 (-0.42)
Sales Growth	0.0007*** (3.26)	0.0007*** (3.29)	-0.0005 (-0.94)	-0.0014*** (-4.67)
Z-Score	-0.0166*** (-4.66)	-0.0141*** (-3.86)	-0.0161*** (-2.80)	-0.0219*** (-2.99)
Firm Maturity	-0.0974*** (-3.39)	-0.0614** (-2.59)	-0.0427 (-1.19)	-0.0183 (-0.26)
MTB	-0.0021*** (-3.43)	-0.0019*** (-3.41)	-0.0000 (-0.04)	0.0017** (2.64)
Analyst	-0.0814*** (-3.06)	-0.0569* (-1.92)	-0.0569** (-2.28)	-0.0993*** (-3.45)
St.Dev.(Profitability)	0.0011* (1.87)	0.0013** (2.46)	0.2079 (1.00)	0.1750 (0.72)
Callable		0.4079*** (6.82)	0.4130*** (9.79)	0.3699*** (11.23)
Secured		0.1717*** (3.99)	0.1100* (2.01)	0.0643 (1.33)
Loan Term		0.0161 (0.73)	0.0029 (0.30)	0.0145 (0.87)
Loan Size		-0.0247 (-1.40)	-0.0362*** (-2.90)	-0.0305*** (-5.18)
Loan Purpose FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes		
Industry FE	Yes	Yes		
Lender Parent FE	Yes	Yes		
Time × Industry FE			Yes	
Time × Lender FE			Yes	
Time × Lender × Industry FE				Yes
Observations	1,708	1,700	1,445	1,106
Adjusted R-squared	0.5867	0.6632	0.7693	0.8455