# Nature-Related Risks in Syndicated Lending*

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## Abstract

This study examines how nature-related risks are considered in syndicated lending, showing that firms highly dependent on ecosystem services (nature–dependent firms) incur higher financing costs. Using U.S. syndicated loan data and a novel nature dependency measure, we find a 1% rise in nature dependency results in a 0.21% increase in loan spreads. Leveraging the 2019 Endangered Species Act (ESA) amendment as an exogenous shock, we show regulatory relaxation lowered spreads for nature–dependent firms. Regulating ecosystem services – vital to environmental stability – exert the most influence on lending costs, suggesting that natural capital risks are increasingly internalized by financial markets. We also highlight the role of growth potential and refinancing risk in how banks price nature dependency of borrowers.

**Keywords**: nature, biodiversity, syndicated loans, debt

JEL classification:

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## 1. Introduction

The global economy heavily relies on natural resources, yet economic activities like manufacturing, agriculture, logging, overfishing, and urban expansion are also causing damage to land and water ecosystems. From 1992 to 2014, while global wealth per person rose by over 90%, natural resources declined by more than 30% (Dasgupta, 2021). This degradation of natural ecosystems leads to a dramatic reduction in the millions of living organisms that not only support our mental well-being but are also essential for economic activities worth billions of dollars (Costanza et al., 1997)

One concern is that such massive degradation of natural ecosystems can have enormous implications for operations of firms. Ecosystem degradation is particularly risky for firms because of the potential regulatory crackdown or restriction of firms' activities. A recent example of this is the delay Tesla faced at its flagship Berlin gigafactory. A German state court halted Tesla's construction over concerns about its potential to strain already declining groundwater levels and affect nearby forests and communities. Tesla now aims to expand its operations, but it faces similar environmental and regulatory challenges.[1] This case highlights how companies may encounter significant delays or restrictions when their operations impact local ecosystems. Additionally, firms' dependency on natural resources can lead to significant additional costs due to environmental protection requirements. For instance, Tesla implemented erosion control measures at its Austin gigafactory to prevent the Colorado River from runoff.[2] This ties into the critical role of mass stabilization, an ecosystem service that naturally prevents soil erosion and landslides through vegetation, ensuring the stability of land—particularly around areas such as manufacturing facilities. Such measures highlight how firms may face substantial costs when operations rely heavily on natural resources and local ecosystem stability.

However, there is little evidence to show that financial market participants consider these nature–related risks. Understanding how natural capital is priced is important

[1] See: https://tinyurl.com/fortune-tesla-gigafactory
[2] See: https://tinyurl.com/tesla-austin-gigafactory

because it can guide financing towards more sustainable projects. This means supporting businesses that rely less on natural resources helping firms explore less resource-intensive opportunities and manage the related risks effectively.

Banks are a crucial source of financing for many firms in the economy, enabling them to execute projects that often rely on various services provided by nature. Various studies have highlighted the role of banks in the context of pollution and carbon emissions (Green and Vallee, 2022; Bellon, 2021; Kacperczyk and Peydro, 2021). However, very little is known if and to what extent banks consider nature–related risks in their decision making. In this paper we take a first step towards bridging this gap.

We study the US syndicated loan market for this analysis. We use the syndicated loan data from Thomson/Refinitiv LoanConnector. For our nature–related data, we use natural capital dependency and impact measures developed by S&P Sustainable1, a division of S&P Global. This database scores firms on their reliance on 21 ecosystem services, developed in partnership with scientists and United Nations Environment Programme (UNEP), based on Taskforce on Nature-related Financial Disclosures' (TNFD) recommendations. S&P calculates a nature-dependency score by assessing how businesses rely on ecosystem services, indicating exposure to related risks. 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. These scores are based on proprietary geospatial data at the asset level for each company and its surrounding ecosystem. We provide more details later in Section (2.1). For our analysis, we focus on the sample of US firms.

First we document that loan spreads are positively correlated with the *materiality* of a firm's dependency on natural capital and the ecosystems. A 1% increase in material dependency score is associated with 0.21% increase in loan spreads. This represents roughly 16% of the standard deviation of loan spreads in the sample. To account for lender-specific and industry-specific unobserved factors that may influence lending decisions over time, we include multiple layers of fixed effects. First, we control for lender-specific time-varying factors by employing lender $\times$ time fixed effects. Second, we address industry-specific shocks that could impact loan spreads and firms' natural capital exposure using industry $\times$ time fixed effects. Our strictest specification incorporates lender $\times$ industry $\times$ time fixed effects to capture both lender and industry-specific time-varying factors that might confound the results. While our preferred time unit is a half-year, our findings remain consistent even when using quarters. Following the existing literature, we also control for other loan-level characteristics such as the amount of the loan, the maturity, whether the loan is secured or not, and if the loan is callable. However, across all these specifications, we continue to obtain similar results.

Our baseline results is consistent with banks pricing charging higher spreads from firms that are more dependent on nature for their operations. However, they could be driven by other considerations such as pollution and other environmental impact associated with their operations other than their dependency on nature. Hence, for identification, we employ the US government's relaxation of the Endangered Species Act (ESA) in August 2019. 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, in 2019, under the Trump administration, the criteria for classifying a species as "endangered" were relaxed, and automatic protections for "threatened" species were removed, reducing regulatory burdens and making it easier for firms to exploit natural resources. This reduced regulatory burdens for firms, particularly those dependent on natural resources, making them potentially less risky. 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.

Loan spreads of firms with more natural resource dependency decrease in the six quarters following the amendment of the ESA in 2019 as compared to before. Economic magnitudes are also meaningful. A 1% higher material dependency score is associated with 0.82% lower spreads after the enactment of the law. As before, the results are obtained after employing lender $\times$ industry $\times$ time fixed effects making it highly unlikely that lender and industry specific time varying unobserved shocks could bias our results. Additionally, we find little evidence of pre-trends consistent with the causal interpretation of the results.

Next we provide an additional set of results to further validate the main findings. In this context, first, we explore which of the 21 ecosystem services are priced by banks. Based on the classification by Costanza et al. (1997), we group these services into three categories: Regulating, Provisioning, and Supporting services. Our findings indicate that the results are primarily driven by Regulating services, which aligns with the general view that these ecosystem services represent the most significant source of natural capital's economic value (Pascual et al., 2010; Kurth et al., 2021).

Second, we explore the association with nature–related risks and other loan terms. Consistent with banks perceiving firms with higher natural capital dependency as risky, we also find that banks reduce loan maturity and they are more likely to issue secured loans for firms with higher nature dependency.

Third, we verify that our results hold when the sample is restricted to recent years, post-2017. This is consistent with the idea that natural capital risks have become more prominent in recent years, further validating the relevance of our findings.

Additionally, to ensure the robustness of our results, we show that controlling for ESG ratings does not affect our findings, suggesting that banks are responding specifically to firms' natural capital dependency rather than their overall ESG performance. This addresses concerns that the loan spreads might be influenced by broader sustainability metrics.

Next we investigate the specific risks that the banks are pricing in this context. First, we find that banks perceive firms with potential asset substitution risk and volatile cash flows as more risky. This is implied by our results being driven by nature–dependent firms with relatively high growth potential in our sample. Second, banks also seem to price possible future refinancing risk by nature–dependent firms as highlighted by our result showing that nature–dependent firms with more short term debt are perceived as particularly risky.

We contribute to multiple strands of literature. First, our study complements a large literature investigating the role of climate change–related issues such as carbon emissions (e.g., Kacperczyk and Peydro, 2021; Ehlers et al., 2022; Bolton and Kacperczyk, 2021, 2023), pollution (e.g., Hsu et al., 2023), sea–level rise (e.g., Acharya et al., 2022; Nguyen et al., 2022; Goldsmith-Pinkham et al., 2023; Jiang et al., 2023) on financial markets. We complement this strand of literature by investigating the impact of nature–related risks in the syndicated loan market. Although similar, nature–related risks are distinctly different from the existing climate change related issues. The nature-dependency measure we use encompasses a much broader range of ecosystem services. For instance, storm and flood protection—-which may relate closely to sea-level rise—-is only one of twenty–one ecosystem services included in our nature-dependency measure, indicating a larger, more comprehensive view of natural dependencies. To the best of our knowledge, we are the first to undertake such an analysis.

Second, our study also adds to the growing body of literature that looks at how nature and biodiversity risks affect financial markets. Giglio et al. (2023) show that biodiversity risk already impacts stock prices. Garel et al. (2023) find that the Kunming Declaration caused regulatory uncertainty, affecting international stock prices. Other studies examining the link between biodiversity risk and stock prices include Chen et al. (2023) and Coqueret and Giroux (2023). In addition to equities, Hoepner et al. (2023) study the impact of biodiversity risk on the credit default swap (CDS) term structure. We complement these studies by focusing on how nature-related risk impacts the syndicated loan market. Like Garel et al. (2023), we find that regulations concerning biodiversity and nature preservation are reflected in the syndicated loan market.

Finally, our study is also related to the broader literature in 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.

## 2. Data description

### *2.1. Nature-related Data*

Our measure of dependency on nature and ecosystem related services come from the S&P Sustainable1 database. The database is the result of a collaboration between the UNEP and S&P Global (S&P). The metrics in this database are based on the guidelines of the TNFD in its Beta framework. It measures nature-related risk by providing scientifically robust and actionable analyses of nature impacts and dependencies, developed with the guidance of the Framing the Future for Nature Knowledge, which consists of more than 270 global organizations representing financial institutions, corporations, governments, academia, and advocacy groups.

The approach scores firms' dependencies on nature and twenty-one ecosystem services[3] on a scale from 0 (no dependency) to 1 (very high dependency) based on the location of their business activities. This score is calculated by breaking down total turnover into different economic sectors and then applying scores for the materiality of these sectors on these twenty-one individual ecosystem services, the relevance of the service based on the geographic location of company assets, and the resilience of the particular ecosystem. The focus of the database on the materiality of nature-related risks makes this measure particularly relevant for our purpose. The database provides overall and material dependency scores both at the aggregate firm level and for each firm on each of the twenty-one individual ecosystem services. The data is cross-sectional and does 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

[3] We provide a list of the twenty-one ecosystem services in the **Appendix Table A2**.

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.

If we again consider Tesla as an example, it 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 Austin facility's proximity to a flood-prone zone[4]. As per its impact on nature, Tesla's condition-adjusted area is primarily driven by its proximity to key protected areas which is consistent with its Berlin gigafactory's location near to a forest which is home to protected wildlife.[5]

We are unaware of other such data. For example, Garel et al. (2023) 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. (2023), MSCI's data coverage is relatively narrow, focusing only on land use and biodiversity without offering a more comprehensive set of measures.

[4]See: `https://tinyurl.com/austin-tesla-groundwater`

[5]See: `https://tinyurl.com/tesla-berlin-gigafactory`

This data differs notably from ESG scores in how it addresses nature dependencies and impacts. In Table 3, we observe low correlations between our nature-related measures and MSCI's Environmental, Social, Governance (E, S, G) scores, as well as with the overall ESG score. This weak correlation suggests our data captures specific aspects of nature interactions not covered by ESG metrics, highlighting that these interactions represent a unique dimension of environmental risk. Unlike traditional ESG scores, which emphasize company policies, social responsibility, and governance practices, our measures specifically quantify how businesses rely on and affect natural ecosystems. This reveals crucial insights about the broader, often untracked, environmental risks posed by companies' dependence on and impact on natural resources.

### *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 2011 and 2023 in US Dollar currency and identify pricing and non-pricing characteristics of each loan tranche. We follow Ertan (2022) and identify our unit of observations loan tranches because loan pricing and other key variables are defined at the tranche level (e.g. amount and maturity). We code 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 a 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 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 2,968 firm-tranche observations for 866 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-semianual) to control for temporal differences in the macroeconomic environment when loans are issued. Detailed variable definitions are in the Appendix.

### 2.5. Summary Statistics

Based on the data described above, we have 2,968 firm–loan–quarter observations across 868 firms between 2011 and 2023.

[Insert Table (1) here]

As shown in Table (1), the mean loan spread of firms in our sample is close to 198 basis points with a standard deviation of 128 basis points. This suggests that loan spreads are highly heterogeneous across firms. The average maturity of loans is close to 51 months with roughly one–third of the loans being secured.

Turning to the nature–related variables, the mean impact of the variables in natural logarithmic scale is 4, suggesting a condition adjusted area of roughly 54 million hectares.

The average dependency is 0.33 in natural logarithmic scale translating to a the actual dependency score of 0.43.

[Insert Table (2) 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 (3) 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 (0.17) 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.

## 3. Baseline Empirical Results

We explore how dependency on nature is associated with cost of debt by estimating the following regression model:

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

where *LnSpread* is the natural logarithm of one plus 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 a host of firm-specific control 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 our 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, which includes controls for loan purpose and $Lender \times Industry \times Time$ fixed effects (column 5), a 1% increase in the natural dependency score is associated with a 0.22% increase in loan spreads. Given that the standard deviation of loan spreads in the sample is 128 basis points, this effect accounts for 16.4% of the standard deviation, underscoring the economic significance of nature dependency in lending decisions. Unlike nature–dependency, we don't find any association between firms' impact on natural ecosystem 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 our point estimates to be driven by very few observations. However, our results remain consistent even when using calendar quarters as the time unit.

### *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 the strictness of the ESA by redefining what qualifies as "endangered" and "threatened" species and allowing commercial operations in previously protected habitats. This policy shift directly impacts the ecosystem and the usage of natural ecosystems. By using this regulatory change, we can better isolate the effects of nature dependency on loan spreads, without interference from other factors like pollution or governance, providing a cleaner identification strategy for our results.

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:

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

where $After\ ESA$ is a dummy variable that takes the value of 1 for quarters after the the ESA amendment and zero for the quarters before. 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 $Impact \times After\ ESA$ 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 natural resources to operate. Consequently, banks would perceive these firms as less risky, and this would likely be reflected in lower borrowing costs, evidenced by reduced loan spreads in the aftermath of the amendment. Hence, we would expect banks to lower loan spreads for firms with higher natural capital dependency post-revision, i.e., $\beta_3$ 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 and column (2) includes all the controls. Consistent with lenders perceiving firms with higher nature dependency less risky, we find that the coefficient on the double interaction term $Material\ Dependency \times After\ ESA$ is negative and statistically significant. The point estimate in column (2) suggests that 1% higher nature dependency score is associated with 0.83% *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 around the regulatory change by adding a double interaction term, $Scope\ Change \times After\ ESA$.

The findings, displayed in Panel B of Table (5), show that our results remain robust. The coefficient for $Scope\ Change \times After\ ESA$ is statistically insignificant. However, we continue to obtain a statistically significant negative point estimate on $Material\ Dependency \times After\ ESA$ 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.

Overall, the analysis in this section highlights that banks are likely to consider firms with higher nature dependency riskier and thereby charging them higher spreads.

### *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 0.21% 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. Heterogeneity among Ecosystem Services*

Ecosystem services are categorized into four main types: regulating, provisioning, cultural, and habitat. Based on research from The Economics of Ecosystems and Biodiversity (TEEB) initiative, it is estimated that the annual value of these services exceeds $150 trillion, nearly twice the global GDP (Kurth et al., 2021).

In general, natural ecosystem services can be broadly classified into three main categories: regulating services, provisioning services, and supporting services. Regulating services, which account for 60% of the total ecosystem value, include critical functions such as climate regulation through carbon sequestration, water purification, and disease control. These services help maintain environmental stability, and their value is often calculated by estimating the costs society would face without them. For instance, the value of climate regulation can be assessed by applying carbon prices that reflect the full social costs of carbon emissions.

Provisioning services represent about 7% of the total value. These include the production of essential goods such as food, timber, and medicinal resources derived from natural ecosystems, excluding the portion created through human activities like agriculture or raw material processing. Supporting services encompass cultural and recreational benefits (e.g., tourism), habitat functions (e.g., providing space for biodiversity and aiding soil formation), and spiritual or heritage values. These services contribute to the overall stability and health of ecosystems, ensuring the survival of various species and maintaining long-term environmental sustainability.

Hence, if banks are considering nature dependency when determining loan terms, it is likely that their pricing decisions are mainly influenced by regulating services as it constitute the largest share of ecosystem services' economic value. Given their large economic relevance, disruptions in these services due to a firm's nature dependency could increase risk, making banks more cautious in lending, which could drive higher loan spreads for firms highly reliant on these ecosystem services.

We construct a category-specific dependency score for each firm, we calculate the average nature dependency score of the individual components within each category. This allows us to capture how reliant each firm is on the distinct ecosystem services. We then substitute the overall nature dependency score in our baseline regression with these category-specific scores to examine how dependency on each service type—-regulating, provisioning, or supporting—-affects loan spreads.

[Insert Table (7) here]

The results are documented in Table (7). 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% increase in dependency on ecosystems providing regulating services is associated with 0.52% increase in loan spreads.

This finding aligns with the widely accepted notion that regulating services, such as climate regulation and water purification, represent the most economically significant ecosystem services.

### 3.2.3. Nature–Dependency and Loan Spreads in Recent Years

One limitation of our dataset is that it is purely cross-sectional, meaning we do not observe firms' nature–dependency over time. Hence, if the results are spurious, one might expect that the correlation between nature–dependency and loan spreads would be driven by earlier years in our sample when the considerations of natural capital was likely not as strong in the financial markets. To address this concern, we repeat our baseline analysis, restricting the sample to loans issued after 2017.

[Insert Table (8) here]

The results of the analysis are presented in Table (8). Our findings remain robust and consistent, even when the sample is limited to loans issued after 2017. 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

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 (9) here]

The results of this analysis is presented in Table (9). 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. [6]

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

## 4. Possible Mechanisms

Why do banks consider nature dependency when making lending decisions? We highlight the role of shareholder–creditor conflict in this context. If firms need to reduce their reliance on nature, they may have to invest in costly projects in the short term, which could hurt immediate returns for shareholders. However, if shareholders focus only on short-term profits, they might be against these investments. Avoiding such projects can boost short–term gains but makes the firm riskier in the long run, especially if future nature–related shocks force the firm to make these investments under more challenging

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

circumstances. This increased risk makes these firms less attractive for creditors, as they may face more uncertainty and cash flow problems over the longer horizon. Towards this end, we provide two set of evidence based on the institutional and legal context in which the firms operate.

### *4.1. Role of Future Growth Potential*

We investigate how future growth potential of firms influence the relationship between loan spreads and nature dependency. This is particularly relevant as it provides insight into how banks may assess and price the nature-dependency risk in firms with limited growth potential.

On the one hand, lenders may see nature–dependent firms, especially those with high growth potential, as riskier because realizing the growth potential would imply increased reliance on ecosystem resources. This can lead to greater exposure to resource scarcity and regulatory risks associated with their business activities.

On the other hand, nature–dependent high–growth firms could strategically utilize their reliance on natural resources to drive future revenue. By capitalizing on their access to critical natural inputs, these firms may create innovative products, expand market share, and boost profitability. This improved financial outlook reduces the likelihood of default, making them less risky to lenders.

To investigate these hypotheses, we sort firms based on their ex-ante market-to-book ratio and sales growth, categorizing firms in each period as high-growth if they fall in the top tercile of each of these measures. We then modify our baseline equation (1) to interact this variable (*High_Growth*) with our nature-related measures, namely, nature-dependency (*Material Dependency*) and impact (*Impact*).

[Insert Table (10) here]

The results are shown in Table (10). Columns (1) and (2) present the results of the subsamples of low and high–growth firms, respectively. As can be seen, we obtain a positive and statistically significant coefficient on *Material Dependency* in both subsamples. However, the coefficient in column (2), for high–growth firms is statistically greater than the coefficient in column (1), implying that lenders perceive nature–dependent and high–growth firms riskier. This is consistent with the explanation that lenders expect high–growth firms not able to fully capitalize on their growth potential due to their reliance on nature, thereby, generating less cash flows and becoming risky.

In summary, our findings show that high-growth firms face higher loan spreads when they are more dependent on natural ecosystems. This is consistent with a heightened perception of transition risk among lenders when growth and resource dependency coincide.

*4.2. Debt Maturity Profile*

We next examine the risk of refinancing. Firms with more short term debt need to refinance more frequently. When firms seek refinancing, they face multiple risks, including changes in market conditions that can sharply increase interest rates. Nature-dependency is one of the several risk factors that can make refinancing costlier, as firms dependent on nature may appear riskier to lenders due to potential environmental or regulatory challenges. These firms also risk lenders underestimating their future viability, which could result in denial of refinancing, potentially forcing inefficient liquidation or the sale of important assets at low prices (Diamond, 1991; Choi et al., 2021), thereby, rendering losses to existing lenders. This underscores how lenders may consider nature-dependency a critical factor in their decisions, potentially impacting firms' cost of borrowing.

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 (*Short Term*). We then interact this variable to 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 (11) here]

The results of the analysis is shown in Table (11). 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 the subsamples. However, it is only statistically significant in column (2), i.e., in the subsample of firms with high proportion of short–term debt. This is consistent with the explanation that lenders perceive borrowers with high short–term debt and being more dependent on nature as risky. In column (3), we find that the coefficient on the double interaction term, $Material\ Dependency \times ShortTerm$, is positive and significant at the 1% level implying that the point estimates in the two subsamples are different from each other.

## 5. Discussion on Double Materiality

Our results show that banks in the syndicated loan market are actively considering borrowers' nature-dependency when setting loan terms, yet they do not similarly account for borrowers' impact on nature and its ecosystems. This distinction suggests that banks prioritize risks directly affecting their clients' financial health over broader consequences on ecosystems, bringing into question how banks perceive and apply the principle of double materiality. Double materiality refers to the idea that a company's impacts on nature are not only a risk to nature but also financially material to the business itself. By focusing on dependency without considering impact, banks may be overlooking the wider risks that borrowers' business footprints could pose to the ecosystems and communities surrounding them. This selective pricing approach indicates that, at least in the syndicated loan market, double materiality may not be fully integrated into environmental risk assessments.

Several factors may explain why banks focus on nature–dependency but do not account for firms' impacts on nature when setting loan terms. First, accurately assessing the impact of a firm's activities on broader ecosystem requires complex data, methodologies, and models that may not be readily available or uniformly applied across banks. Measuring a firm's dependence on natural resources, like water or raw materials, may be simpler than quantifying the broader, often indirect, environmental harm their activities cause.

Second, banks may have an incentive to "greenwash" their portfolios by selectively highlighting sustainability metrics that paint them in a favorable light while downplaying or ignoring metrics related to their impact on nature. By emphasizing nature-dependency, they can signal environmental responsibility without having to fully address or quantify the firm's environmental footprint.

Lastly, it's possible that banks do consider impacts on nature to some extent, but limitations in our dataset or sample size may make it challenging to observe statistically significant effects.

## 6. Conclusion

In this paper, we explore whether firms that rely more heavily on ecosystem services are viewed as riskier by banks in the syndicated loan market. Our analysis shows that a 1% increase in a firm's nature-dependency leads to an approximate 0.2% rise in loan spreads, suggesting that banks do indeed perceive these firms as carrying higher risk. This effect is most pronounced for regulating ecosystem services, which aligns with industry expectations regarding their economic importance. Additionally, banks tend to shorten loan maturities and require more collateral from firms with higher nature-dependency, further reflecting their heightened risk perceptions.

Moreover, we find that growth potential and refinancing risk of firms play an important role in moderating the relationship between nature dependency and loan spreads. Specifically, nature dependent firms with higher growth potential (or higher refinancing risk as proxied by more short term debt) is perceived as more risky by the lenders. These findings contribute to a growing understanding of how natural capital risks influence financial markets and highlight the importance of considering ecosystem services in corporate finance.

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**Table 1 – Summary Statistics**

This table shows the summary statistics. Panel A shows variable statistics. Panel B shows the number of observations by year.

| Variable | N | Mean | SD | p5 | Median | p95 |
|---|---|---|---|---|---|---|
| Spread(bps) | 2,968 | 197.88 | 128.06 | 75.00 | 150.00 | 462.50 |
| Loan Size(mil) | 2,968 | 1064.28 | 1568.77 | 50.00 | 500.00 | 4000.00 |
| Loan Term(mo) | 2,968 | 51.22 | 20.84 | 12.00 | 60.00 | 84.00 |
| Callable | 2,968 | 0.09 | 0.28 | 0.00 | 0.00 | 1.00 |
| Secured | 2,968 | 0.33 | 0.47 | 0.00 | 0.00 | 1.00 |
| Impact | 2,968 | 4.00 | 2.45 | 0.69 | 3.61 | 9.04 |
| Material Dependency | 2,968 | 0.36 | 0.18 | 0.03 | 0.41 | 0.57 |
| Materiality: Regulating Services | 2,968 | 0.12 | 0.09 | 0.00 | 0.12 | 0.27 |
| Materiality: Provisioning Service | 2,968 | 0.07 | 0.09 | 0.00 | 0.03 | 0.29 |
| Materiality: Supporting Services | 2,968 | 0.06 | 0.08 | 0.00 | 0.01 | 0.26 |
| Firm Maturity | 2,968 | 0.22 | 0.53 | -0.64 | 0.26 | 0.91 |
| Leverage | 2,968 | 0.29 | 0.19 | 0.00 | 0.27 | 0.65 |
| MTB | 2,968 | 4.04 | 11.82 | -0.06 | 2.64 | 14.54 |
| Profitability | 2,968 | 0.11 | 0.13 | -0.05 | 0.11 | 0.34 |
| St.Dev.(Profitability) | 2,968 | 0.22 | 5.53 | 0.01 | 0.03 | 0.17 |
| Sales Growth | 2,968 | 10.74 | 26.16 | -17.13 | 6.46 | 51.45 |
| Size | 2,968 | 8.39 | 1.70 | 5.70 | 8.35 | 11.23 |
| Tangibility | 2,968 | 0.24 | 0.21 | 0.03 | 0.17 | 0.73 |
| Z-Score | 2,968 | 3.06 | 3.45 | 0.24 | 2.20 | 9.00 |
| Analyst | 2,968 | 2.23 | 0.86 | 0.69 | 2.40 | 3.37 |

**Table 2 – Industry Heterogeneity**
This table presents summary statistics using the Fama and French 48 industry classification. Panel A displays the number of observations across different Fama French 12 (for brevity) industries in the sample. Panel B highlights the top five industries based on the average level of material dependency on nature among firms in our sample. Lastly, Panel C shows the top five industries according to the average impact on nature attributed to firms in the sample. Industry classifications in Panels B and C are based on Fama and French 48 industries.

**Panel A: Number of Observations by Industry**

| Industry | N |
|---|---|
| Consumer Non-Durables | 256 |
| Consumer Durables | 111 |
| Manufacturing | 448 |
| Energy | 147 |
| Chemicals | 157 |
| Business Equipment & Software | 586 |
| Telecommunication | 93 |
| Wholesale & Retail | 388 |
| Healthcare | 356 |
| Other | 426 |
| Total | 2,968 |

**Panel B: List of Top 5 Industries, Average Dependency**

| Industry | Average Dependency |
|---|---|
| Beer & Liquor | 0.576 |
| Petroleum and Natural Gas | 0.569 |
| Coal | 0.561 |
| Non-Metallic and Industrial Metal Mining | 0.556 |
| Precious Metals | 0.548 |

**Panel C: List of Top 5 Industries, Average Impact**

| Industry | Average Impact |
|---|---|
| Agriculture | 8.703 |
| Petroleum and Natural Gas | 7.763 |
| Non-Metallic and Industrial Metal Mining | 7.507 |
| Coal | 7.296 |
| Transportation | 6.347 |

**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 | 0.17 | 1.00 | | | | |
| (3) MSCI E-Score | 0.05 | -0.29 | 1.00 | | | |
| (4) MSCI S-Score | -0.10 | -0.04 | 0.03 | 1.00 | | |
| (5) MSCI G-Score | 0.04 | -0.08 | -0.08 | 0.06 | 1.00 | |
| (6) MSCI ESG-Score | 0.02 | -0.14 | 0.25 | 0.50 | 0.37 | 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 one plus the loan spreads. The main variables of interest are the natural logarithm of 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. See the Appendix 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

| | Dependent Variable = *Spread* | | | | |
|---|---|---|---|---|---|
| Variables | (1) | (2) | (3) | (4) | (5) |
| *Material Dependency* | 0.3751*** | 0.2869*** | 0.2059*** | 0.2164*** | 0.2214*** |
| | (5.74) | (4.63) | (3.97) | (3.58) | (2.87) |
| *Impact* | 0.0000 | -0.0015 | 0.0022 | 0.0020 | 0.0080 |
| | (0.01) | (-0.29) | (0.37) | (0.40) | (1.00) |
| Leverage | 0.5094*** | 0.3960*** | 0.3995*** | 0.3566*** | 0.3201*** |
| | (7.21) | (6.88) | (4.97) | (4.02) | (5.51) |
| Size | -0.1028*** | -0.0725*** | -0.0884*** | -0.0886*** | -0.1012*** |
| | (-10.39) | (-6.18) | (-5.56) | (-4.87) | (-6.50) |
| Profitability | -0.5037*** | -0.4286*** | -0.4100*** | -0.2985*** | -0.3358** |
| | (-7.26) | (-6.77) | (-5.39) | (-2.95) | (-2.18) |
| Tangibility | 0.1208** | 0.1458*** | 0.1020* | 0.1081** | 0.0460 |
| | (2.18) | (3.23) | (1.73) | (2.09) | (0.58) |
| Sales Growth | 0.0010*** | 0.0007*** | 0.0004 | -0.0001 | -0.0010 |
| | (3.52) | (3.21) | (1.19) | (-0.20) | (-1.43) |
| Z-Score | -0.0140*** | -0.0125*** | -0.0110*** | -0.0122** | -0.0121*** |
| | (-3.57) | (-3.36) | (-2.83) | (-2.62) | (-2.92) |
| Firm Maturity | -0.1165*** | -0.0793*** | -0.0926*** | -0.0964*** | -0.1164*** |
| | (-4.62) | (-3.69) | (-5.01) | (-5.07) | (-5.15) |
| MTB | -0.0033*** | -0.0029*** | -0.0023*** | -0.0019*** | -0.0009 |
| | (-5.60) | (-4.15) | (-3.87) | (-3.35) | (-1.63) |
| Analyst | -0.0742*** | -0.0521** | -0.0497*** | -0.0516*** | -0.0765*** |
| | (-3.05) | (-2.13) | (-3.83) | (-3.54) | (-4.57) |
| St.Dev.(Profitability) | 0.0022*** | 0.0022*** | 0.0031*** | 0.2060*** | 0.2531*** |
| | (3.67) | (3.81) | (4.51) | (9.90) | (5.55) |
| Callable | | 0.3880*** | 0.3787*** | 0.3721*** | 0.3303*** |
| | | (8.75) | (10.87) | (13.10) | (11.31) |
| Secured | | 0.2083*** | 0.1831*** | 0.1872*** | 0.1472*** |
| | | (6.62) | (7.55) | (5.42) | (3.40) |
| Loan Term | | -0.0018 | -0.0142 | -0.0268 | -0.0426** |
| | | (-0.09) | (-0.87) | (-1.60) | (-2.28) |
| Loan Size | | -0.0256** | -0.0240*** | -0.0275*** | -0.0151*** |
| | | (-2.64) | (-2.95) | (-3.50) | (-3.55) |
| Constant | 5.9813*** | 5.7850*** | 5.9833*** | 6.0337*** | 6.2229*** |
| | (84.86) | (54.84) | (44.95) | (48.49) | (44.55) |
| Loan Purpose FE | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | | | |
| Industry FE | Yes | Yes | | | |
| Lender Parent FE | Yes | Yes | Yes | | |
| Time × Industry FE | | | Yes | Yes | |
| Time × Lender FE | | | | Yes | |
| Time × Lender × Industry FE | | | | | Yes |
| Observations | 2,968 | 2,968 | 2,817 | 2,712 | 2,126 |
| Adjusted R-squared | 0.54 | 0.62 | 0.67 | 0.69 | 0.79 |

**Table 5 – Nature Dependency and Loan Spreads around Endangered Species Act**
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 one plus the loan spreads. The main variables of interest are the natural logarithm of nature–dependency (*Material Dependency*) and impact (*Impact*). 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. Fixed effects for industry (FFI48) and time are included as indicated. We cluster standard errors at the firm level and parent level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively

**Panel A: Main Model**

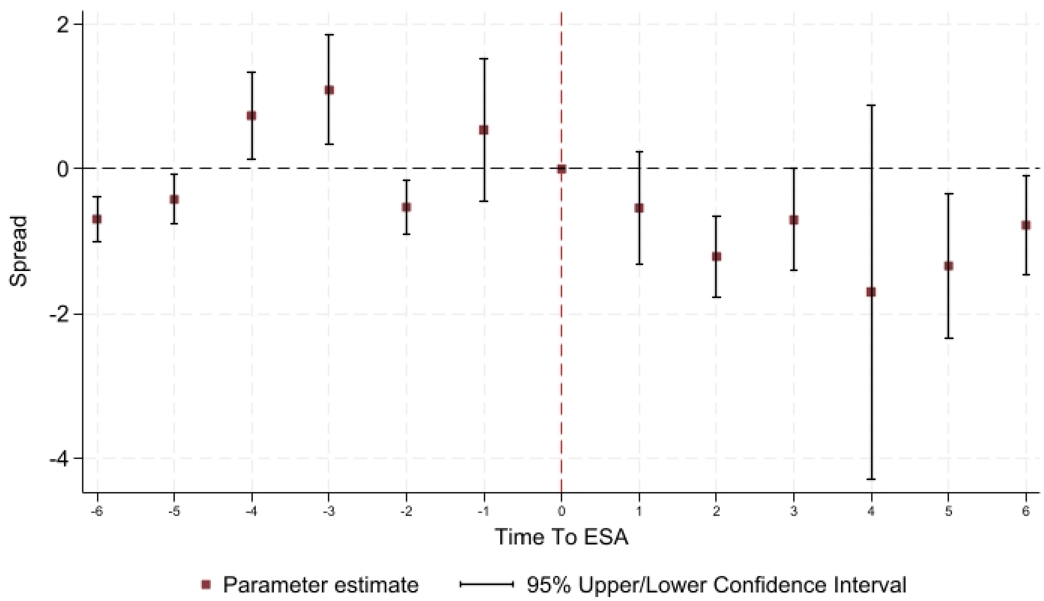
| | Dependent Variable = *Spread* | |
|---|---|---|
| Variables | (1) | (2) |
| *Material Dependency* | 0.6384** | 0.4666*** |
| | (2.59) | (2.96) |
| After ESA | 0.3902** | 0.2659* |
| | (2.75) | (1.96) |
| *Material Dependency* X After ESA | -0.9365** | -0.8332*** |
| | (-2.09) | (-2.85) |
| *Impact* | 0.0327 | 0.0116 |
| | (1.54) | (0.68) |
| *Impact* X After ESA | -0.0177 | -0.0033 |
| | (-1.06) | (-0.23) |
| Observations | 509 | 509 |
| Adjusted R-squared | 0.78 | 0.84 |

**Panel B: Adjusted Model**

| | Dependent Variable = SPREAD | |
|---|---|---|
| Variables | (1) | (2) |
| Material Dependency | 0.5007*** | 0.4959*** |
| | (3.71) | (3.41) |
| After ESA | 0.2088 | 0.1791 |
| | (1.61) | (1.14) |
| Material Dependency X After ESA | -0.7226*** | -0.6924** |
| | (-2.89) | (-2.24) |
| Material Impact | 0.0153 | 0.0163 |
| | (0.81) | (0.95) |
| Impact X After ESA | 0.0036 | 0.0035 |
| | (0.24) | (0.22) |
| Scope Change | -0.0058 | -0.0381 |
| | (-0.19) | (-0.41) |
| Scope Change X After ESA | | 0.0458 |
| | | (0.49) |
| Observations | 491 | 491 |
| Adjusted R-squared | 0.85 | 0.85 |
| **For Both Panels** | | |
| Controls | Yes | Yes |
| Loan Purpose FE | Yes | Yes |
| Time × Lender × Industry FE | Yes | Yes |

**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**

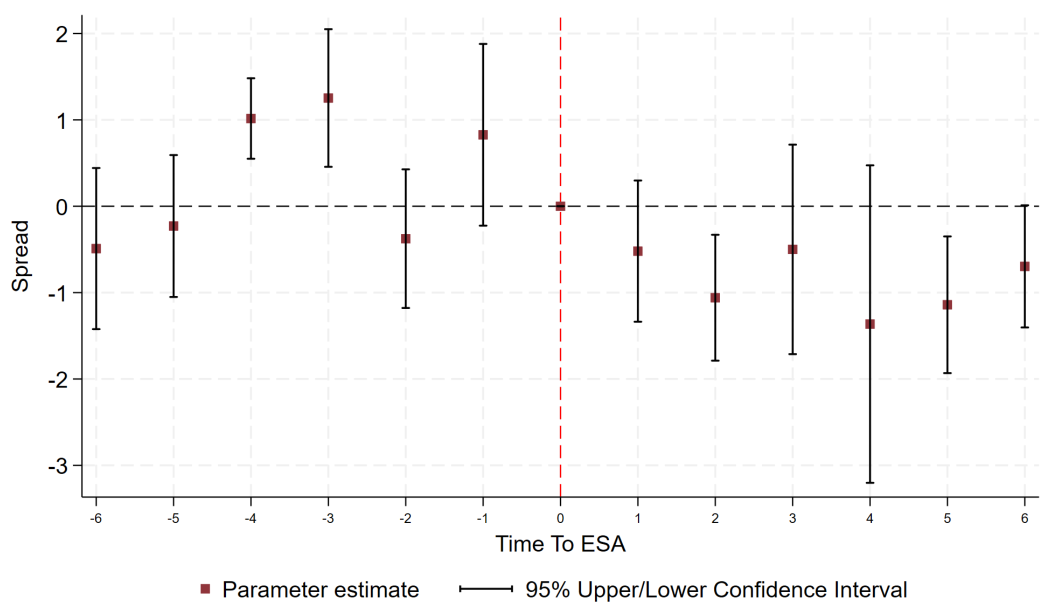


**Table 6 – Nature Dependency and Other Lending Terms**

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 the natural logarithm of nature–dependency (*Material Dependency*) and impact (*Impact*). 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

| | Dependent Variable | |
|---|---|---|
| | = LOAN TERM | = SECURE |
| Variables | (1) | (2) |
| Material Dependency | -0.2331** | 0.2522** |
| | (-2.45) | (2.37) |
| Impact | -0.0089 | -0.0043 |
| | (-1.15) | (-0.78) |
| Leverage | -0.1791** | 0.1085 |
| | (-2.57) | (0.86) |
| Size | -0.1361*** | -0.0101 |
| | (-5.22) | (-1.21) |
| Profitability | -0.2018** | -0.0203 |
| | (-2.18) | (-0.17) |
| Tangibility | 0.0288 | 0.1666 |
| | (0.19) | (0.99) |
| Sales Growth | 0.0009 | 0.0001 |
| | (0.90) | (0.16) |
| Z-Score | 0.0064* | -0.0023 |
| | (1.78) | (-0.57) |
| Firm Maturity | 0.0428 | -0.1106** |
| | (1.65) | (-2.30) |
| MTB | -0.0010 | 0.0003 |
| | (-0.87) | (0.22) |
| Analyst | 0.0197 | -0.0915*** |
| | (0.79) | (-6.91) |
| St.Dev.(Profitability) | -0.1242 | 0.1012 |
| | (-1.39) | (1.42) |
| Callable | 0.4223*** | 0.3443*** |
| | (12.22) | (14.69) |
| Secured | 0.2890*** | |
| | (7.93) | |
| Loan Size | 0.0254** | -0.0178** |
| | (2.04) | (-2.59) |
| Loan Term | | 0.1004*** |
| | | (4.07) |
| Constant | 4.7849*** | 0.2003** |
| | (22.35) | (2.28) |
| Loan Purpose FE | Yes | Yes |
| Time $\times$ Lender $\times$ Industry FE | Yes | Yes |
| Observations | 2,126 | 2,126 |
| Adjusted R-squared | 0.46 | 0.68 |

**Table 7 – 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 one plus 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. 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

| | Dependent Variable = SPREAD | | | |
|---|---|---|---|---|
| Variables | (1) | (2) | (3) | (4) |
| Material Dependency: Regulating Services | 0.4141* | | | 0.4917*** |
| | (1.94) | | | (2.73) |
| Material Dependency: Provisioning Services | | 0.0909 | | -0.1156 |
| | | (0.64) | | (-0.79) |
| Material Dependency: Supporting Services | | | 0.1495 | 0.0125 |
| | | | (0.41) | (0.04) |
| Impact | 0.0066 | 0.0065 | 0.0072 | 0.0061 |
| | (0.80) | (0.85) | (0.86) | (0.72) |
| Leverage | 0.3293*** | 0.3373*** | 0.3353*** | 0.3250*** |
| | (5.59) | (5.37) | (5.25) | (5.26) |
| Size | -0.0988*** | -0.0975*** | -0.0987*** | -0.0991*** |
| | (-6.31) | (-6.03) | (-6.30) | (-6.54) |
| Profitability | -0.3315** | -0.3364** | -0.3295** | -0.3294** |
| | (-2.23) | (-2.12) | (-2.25) | (-2.34) |
| Tangibility | 0.0424 | 0.0471 | 0.0641 | 0.0516 |
| | (0.52) | (0.59) | (0.67) | (0.57) |
| Sales Growth | -0.0010 | -0.0010 | -0.0010 | -0.0010 |
| | (-1.50) | (-1.56) | (-1.59) | (-1.51) |
| Z-Score | -0.0118** | -0.0116** | -0.0115** | -0.0119** |
| | (-2.65) | (-2.39) | (-2.28) | (-2.59) |
| Firm Maturity | -0.1179*** | -0.1183*** | -0.1188*** | -0.1184*** |
| | (-5.10) | (-4.87) | (-5.01) | (-5.04) |
| MTB | -0.0009 | -0.0009 | -0.0008 | -0.0009 |
| | (-1.54) | (-1.48) | (-1.40) | (-1.53) |
| Analyst | -0.0769*** | -0.0768*** | -0.0763*** | -0.0769*** |
| | (-4.65) | (-4.53) | (-4.69) | (-4.64) |
| St.Dev.(Profitability) | 0.2464*** | 0.2287*** | 0.2329*** | 0.2512*** |
| | (5.76) | (6.71) | (6.30) | (5.31) |
| Callable | 0.3308*** | 0.3330*** | 0.3324*** | 0.3306*** |
| | (11.56) | (11.37) | (11.29) | (11.45) |
| Secured | 0.1492*** | 0.1517*** | 0.1517*** | 0.1493*** |
| | (3.57) | (3.68) | (3.70) | (3.63) |
| Loan Term | -0.0434** | -0.0445** | -0.0439** | -0.0428** |
| | (-2.34) | (-2.35) | (-2.37) | (-2.27) |
| Loan Size | -0.0149*** | -0.0150*** | -0.0148*** | -0.0148*** |
| | (-3.50) | (-3.44) | (-3.48) | (-3.53) |
| Constant | 6.2376*** | 6.2709*** | 6.2656*** | 6.2349*** |
| | (42.00) | (42.46) | (40.20) | (40.17) |
| Loan Purpose FE | Yes | Yes | Yes | Yes |
| Time × Lender × Industry FE | Yes | Yes | Yes | Yes |
| Observations | 2,126 | 2,126 | 2,126 | 2,126 |
| Adjusted R-squared | 0.79 | 0.79 | 0.79 | 0.79 |

**Table 8 – 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 (after 2017). The dependent variable is the natural logarithm of one plus the loan spreads (*SPREAD*). The main variables of interest are the natural logarithm of nature–dependency (*Material Dependency*) and impact (*Impact*). 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

| | Dependent Variable = SPREAD | |
|---|---|---|
| Variables | (1) | (2) |
| Material Dependency | 0.3559*** | 0.2108*** |
| | (4.05) | (3.08) |
| Impact | 0.0214 | 0.0110 |
| | (1.39) | (0.76) |
| Leverage | 0.3245*** | 0.2403*** |
| | (3.19) | (3.81) |
| Size | -0.1235*** | -0.1042*** |
| | (-7.87) | (-7.75) |
| Profitability | -0.3236** | -0.1875 |
| | (-2.12) | (-1.60) |
| Tangibility | 0.0902 | -0.0138 |
| | (0.54) | (-0.09) |
| Sales Growth | -0.0012* | -0.0008 |
| | (-1.76) | (-1.64) |
| Z-Score | -0.0186*** | -0.0206*** |
| | (-3.88) | (-5.80) |
| Firm Maturity | -0.0786*** | -0.0756** |
| | (-2.82) | (-2.71) |
| MTB | -0.0003 | -0.0005 |
| | (-0.23) | (-0.56) |
| Analyst | -0.1384*** | -0.0774* |
| | (-4.49) | (-1.80) |
| St.Dev.(Profitability) | 0.3738*** | 0.3196*** |
| | (8.14) | (5.88) |
| Callable | | 0.4072*** |
| | | (10.56) |
| Secured | | 0.1474** |
| | | (2.40) |
| Loan Term | | 0.0001 |
| | | (0.01) |
| Loan Size | | -0.0228*** |
| | | (-3.06) |
| Constant | 6.2333*** | 6.1294*** |
| | (73.49) | (105.00) |
| Loan Purpose FE | Yes | Yes |
| Time × Lender × Industry FE | Yes | Yes |
| Observations | 925 | 925 |
| Adjusted R-squared | 0.76 | 0.82 |

**Table 9 – Nature Dependency, Loan Spread, and ESG Ratings**

This table investigates if the results are robust to controlling for ESG scores of firms. The dependent variable is the natural logarithm of one plus the loan spreads (*SPREAD*). The main variables of interest are the natural logarithm of 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. 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

| | Dependent Variable = SPREAD | | | |
|---|---|---|---|---|
| Variables | (1) | (2) | (3) | (4) |
| Material Dependency | 0.2552*** | 0.2876*** | 0.2993*** | 0.2964*** |
| | (4.14) | (4.85) | (5.10) | (5.46) |
| Impact | 0.0131 | 0.0133 | 0.0149 | 0.0126 |
| | (1.11) | (1.24) | (1.45) | (1.10) |
| MSCI E-Score | -0.0160 | | | |
| | (-1.27) | | | |
| MSCI S-Score | | 0.0131 | | |
| | | (0.82) | | |
| MSCI G-Score | | | -0.0197** | |
| | | | (-2.06) | |
| MSCI ESG-Score | | | | 0.0005 |
| | | | | (0.08) |
| Leverage | 0.2917*** | 0.2751*** | 0.2528*** | 0.2663*** |
| | (5.63) | (5.82) | (6.18) | (5.32) |
| Size | -0.0937*** | -0.1043*** | -0.1071*** | -0.1046*** |
| | (-5.90) | (-5.63) | (-6.26) | (-5.69) |
| Profitability | -0.3170 | -0.2991 | -0.2893 | -0.2985 |
| | (-1.39) | (-1.23) | (-1.18) | (-1.22) |
| Tangibility | -0.0165 | 0.0311 | 0.0358 | 0.0223 |
| | (-0.10) | (0.24) | (0.25) | (0.16) |
| Sales Growth | -0.0012** | -0.0011** | -0.0011* | -0.0012** |
| | (-2.07) | (-2.18) | (-1.79) | (-2.06) |
| Z-Score | -0.0108*** | -0.0113*** | -0.0122*** | -0.0117*** |
| | (-3.12) | (-2.81) | (-3.16) | (-2.93) |
| Firm Maturity | -0.1415*** | -0.1431*** | -0.1382*** | -0.1417*** |
| | (-3.29) | (-3.14) | (-2.86) | (-3.27) |
| MTB | -0.0003 | -0.0004 | -0.0001 | -0.0003 |
| | (-0.31) | (-0.47) | (-0.17) | (-0.31) |
| Analyst | -0.0931*** | -0.0932*** | -0.0910*** | -0.0910*** |
| | (-5.02) | (-4.73) | (-4.88) | (-5.43) |
| St.Dev.(Profitability) | 0.2548*** | 0.2364*** | 0.2484*** | 0.2459*** |
| | (5.77) | (5.87) | (7.27) | (6.67) |
| Callable | 0.3087*** | 0.3089*** | 0.3076*** | 0.3083*** |
| | (12.24) | (12.02) | (12.17) | (12.38) |
| Secured | 0.1489*** | 0.1516*** | 0.1548*** | 0.1546*** |
| | (2.75) | (3.08) | (3.12) | (3.07) |
| Loan Term | -0.0398** | -0.0401** | -0.0406** | -0.0408** |
| | (-2.15) | (-2.23) | (-2.28) | (-2.26) |
| Loan Size | -0.0141*** | -0.0135*** | -0.0133*** | -0.0132*** |
| | (-3.50) | (-3.07) | (-3.19) | (-3.27) |
| Constant | 6.2799*** | 6.1963*** | 6.3862*** | 6.2600*** |
| | (30.65) | (34.75) | (44.22) | (30.38) |
| Loan Purpose FE | Yes | Yes | Yes | Yes |
| Time × Lender × Industry FE | Yes | Yes | Yes | Yes |
| Observations | 1,908 | 1,908 | 1,908 | 1,908 |
| Adjusted R-squared | 0.78 | 0.78 | 0.78 | 0.78 |

**Table 10 – Nature Dependency, Loan Spread, and Growth Potential**

This table investigates whether the relationship between nature–dependency and impact is moderated by the growth potential of firms. We proxy a firms growth potential with the Market-to-Book (MTB) ratio and the sales growth ratio (Sales Growth). Firms with their MTB and sales growth ratio in the highest tercile in a given time period are defined as high–growth (*High Growth*) firms. The dependent variable is the natural logarithm of one plus the loan spreads (*SPREAD*). The main variables of interest are the double interaction term between nature–dependency (*Material Dependency*) and *High Growth* (Material Dependency $\times$ High Growth) as well as the interaction term, Impact $\times$ High Growth. 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

| | Dependent Variable = SPREAD | | |
|---|---|---|---|
| Variables | (1) | (2) | (3) |
| Material Dependency | 0.1523* | 2.5715*** | 0.1523* |
| | (1.93) | (6.04) | (1.90) |
| Material Dependency x High Growth | | | 2.4193*** |
| | | | (6.36) |
| Impact | 0.0073 | 0.1017** | 0.0073 |
| | (0.70) | (2.48) | (0.70) |
| Impact x High Growth | | | 0.0944*** |
| | | | (2.79) |
| Sample Restrictions | High Growth = 0 | High Growth = 1 | |
| Controls | Yes | Yes | Yes |
| Loan Purpose FE | Yes | Yes | Yes |
| TimeXLenderXIndustry FE | Yes | Yes | Yes |
| Observations | 1,839 | 204 | 2,043 |
| Adjusted R-squared | 0.80 | 0.91 | 0.81 |

**Table 11 – 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 is considered as high short–term. debt (*High St.Debt*) firms. The dependent variable is the natural logarithm of one plus 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. 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

| | Dependent Variable = SPREAD | | |
|---|---|---|---|
| Variables | (1) | (2) | (3) |
| Material Dependency | 0.2447 | 1.0205*** | 0.2447 |
| | (1.46) | (4.08) | (1.43) |
| Material Dependency x High St.Debt | | | 0.7757*** |
| | | | (3.24) |
| Impact | 0.0192** | -0.0323 | 0.0192** |
| | (2.50) | (-1.47) | (2.38) |
| Impact x High St.Debt | | | -0.0515** |
| | | | (-2.18) |
| Sample Restrictions | High St.Debt = 0 | High St.Debt = 1 | |
| Controls | Yes | Yes | Yes |
| Loan Purpose FE | Yes | Yes | Yes |
| TimeXLenderXIndustry FE | Yes | Yes | Yes |
| Observations | 1,207 | 546 | 1,753 |
| Adjusted R-squared | 0.82 | 0.87 | 0.84 |

# Appendix

**Table A1 – 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** | |
| *Spread* | 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 un-logged in terms of basis points (bps) for descriptive purposes. *Source: LoanConnector.* |
| *Loan Term* | 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) *Source: LoanConnector.* |
| *Loan Size* | Natural logarithm of the amount of a loan in millions of dollars. (TRANCHE_AMOUNT) |
| *Secured* | Indicator variable equal to one if a loan is secured, and zero otherwise. (SECURE_D) *Source: LoanConnector.* |
| *Loan Purpose* | The loan purpose(PRIMARY_PURPOSE). *Source: LoanConnector.* |
| *Callable* | Indicator variable equal to one if a loan has a call protection, and zero otherwise.( CALL_PROTECTION) *Source: LoanConnector.* |
| **Firm and other characteristics** | |
| Size | The natural logarithm of total assets (ITEM2999). Where specifically noted, we report this variable in millions for descriptive purposes. |
| MTB | The market value of equity (ITEM7210) scaled by book value of equity (ITEM3501). |
| Leverage | Total long-term debt (ITEM3255) scaled by total assets (ITEM2999). |
| Tangibility | Net property, plant, and equipment (ITEM2501) divided by total assets (ITEM2999). |
| Z-Score | Calculated as 1.2×(( ITEM2201- ITEM3101)/ ITEM2999) + 1.4×( ITEM3495/ ITEM2999) + 3.3×( ITEM1551/ ITEM2999) + 0.6×(( ITEM7210)/ ITEM3351) + 0.999×( ITEM1001/ ITEM2999). |
| Profitability | The ratio of operating income (ITEM1250) scaled by sales (ITEM1001). |
| St.Dev.(Profitability) | The standard deviation of profitability over the previous 8 quarters. |
| Analyst | The natural logarithm of the number of unique analysts issuing a forecast for the next year per I\B\E\S database. *Source: I\B\E\S.* |
| Sales Growth | Sales growth, measures as (ITEM8698) |
| Firm Maturity | Retained earnings (ITEM3495) divided by total assets (ITEM2999). |
| Lender Parent | The lender parent (LENDER_PARENT_ID). Source: LoanConnector. |

**Table A2 – 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** |
|---|---|
| *Regulating Services* | Bioremediation, Regulation of Climatic Conditions, Disease Control, Filtration, Flood and Strom Protection, Ground and Surface Water, Maintaining Nursery Habitats, Mass Stabilisation & Erosion Control, Pest Control, Pollination Services, Soil Quality, Water Flow Maintenance, Water Quality<br>*Source: S&P Sustainable1.* |
| *Provisioning Services* | Fibres & Other Materials, Genetic Materials, Surface Water<br>*Source: S&P Sustainable1.* |
| *Support Services* | Buffering & Attenuation of Mass Flows, Dilution by Atmosphere and Ecosystems, Mediation of Sensory Impacts, Ventilation<br>*Source: S&P Sustainable1.* |