

# **The Paradox of Sustainable Finance: Evaluating the Empirical Impact of U.S. Green Lending Policies on Corporate Borrowing Costs and the Mitigation of Commercial Credit Risk**

## **Authors**

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## **Abstract**

The integration of environmental criteria into commercial lending decisions presents a fundamental paradox: while green lending policies aim to incentivize sustainable corporate behavior through preferential borrowing terms, their actual impact on credit risk mitigation and borrowing costs remains empirically contested. This study investigates the relationship between U.S. green lending policies, corporate borrowing costs, and commercial credit risk through a quantitative analysis of syndicated loan data from 2011 to 2023. Drawing on a theoretical framework combining adverse selection theory with environmental signaling mechanisms, we examine whether green borrower designation correlates with reduced loan spreads and whether such preferential pricing genuinely reflects lower credit risk. Our empirical analysis, employing difference-in-differences estimation and panel regression techniques, reveals that green-certified firms obtain average loan spread reductions of 18-23 basis points compared to non-green counterparts, with the effect intensifying following the 2015 Paris Agreement. However, we identify a critical paradox: green borrowers do not exhibit statistically significant improvements

in traditional credit risk metrics, with default probabilities differing by only 1.2% ( $p=0.18$ ) between green and brown firms. This suggests that green lending discounts may reflect lender preference rather than risk-based pricing, raising concerns about the efficiency of sustainability-linked credit allocation. The study contributes to sustainable finance literature by empirically documenting the decoupling of environmental signaling from credit risk fundamentals and offers practical recommendations for aligning green lending policies with robust risk assessment frameworks.

**Keywords:** Sustainable Finance, Green Lending, Credit Risk, Borrowing Costs, Paris Agreement, Signaling Theory, Syndicated Loans

## 1. Introduction

### 1.1 Background

The global financial system has witnessed a paradigm shift toward the integration of environmental, social, and governance (ESG) criteria into credit allocation decisions over the past decade. This transformation, broadly categorized under the umbrella of sustainable finance, reflects growing recognition among financial institutions that climate-related risks and environmental degradation pose material threats to loan portfolio performance. The United States, despite the absence of comprehensive federal climate legislation, has experienced substantial growth in green lending instruments, including sustainability-linked loans (SLLs), green bonds, and ESG-integrated credit facilities. According to industry data, U.S. SLL issuance exceeded \$200 billion in 2022, representing a compound annual growth rate of over 40% since 2018.

The theoretical rationale for green lending policies rests on two interconnected premises. First, borrowers demonstrating environmental responsibility are presumed to exhibit lower exposure to transition risks, regulatory penalties, and reputational damages, thereby justifying preferential borrowing terms. Second, by offering economic incentives for sustainable behavior, green lending policies are expected to catalyze corporate investment in emissions reduction, energy efficiency, and climate adaptation. Financial institutions, in turn, position these policies as mechanisms for both risk mitigation and stakeholder value creation, aligning their credit portfolios with broader societal objectives.

However, the empirical foundation supporting these premises remains surprisingly fragile. While numerous studies have documented the existence of a "green premium" in corporate borrowing—lower interest rates for environmentally responsible firms—the mechanisms through which this discount operates and its relationship to actual credit risk reduction are poorly understood. This uncertainty gives rise to what we term the "Paradox of Sustainable Finance":

green lending policies may reduce borrowing costs for designated firms without corresponding improvements in their fundamental creditworthiness, creating a misallocation of credit that undermines both financial stability and environmental objectives.

## **1.2 Problem Statement**

The existing literature on sustainable finance has produced conflicting findings regarding the relationship between green borrower status, borrowing costs, and credit risk. Goncharenko et al. (2022) identified a "green-meets-green" effect in syndicated lending, wherein environmentally committed banks offer discounts to green borrowers, particularly following the Paris Agreement . Conversely, other research has found that carbon intensity does not constitute material information for bank lending decisions, with environmental scores having only incidental economic effects on loan spreads . Ivanov, Kruttli, and Watugala (2023) demonstrated that banks respond quickly to transition risk realizations by adjusting loan terms for affected firms, but their analysis focused primarily on regulatory shocks rather than voluntary green lending programs . The International Monetary Fund's recent working paper documented a carbon risk premium in U.S. corporate loans, but noted that this premium has been declining in recent years, suggesting that market participants may be de-emphasizing environmental factors in credit pricing .

These contradictory findings point to a fundamental gap in the literature: no comprehensive empirical framework exists that simultaneously evaluates (a) the magnitude and persistence of green lending discounts, (b) the relationship between green certification and actual credit risk metrics, and (c) the mechanisms through which green lending policies affect corporate borrowing costs. Without such integrated analysis, policymakers, regulators, and financial institutions lack the evidence base necessary to design effective sustainable finance policies.

**The specific unsolved issue this study addresses is:** Do U.S. green lending policies reduce corporate borrowing costs through genuine credit risk mitigation, or do they operate primarily through preference-based mechanisms that decouple environmental signaling from fundamental creditworthiness?

## **1.3 Objectives of the Study**

**General objective:** To evaluate the empirical relationship between U.S. green lending policies, corporate borrowing costs, and commercial credit risk, and to determine whether preferential pricing for green borrowers reflects genuine risk mitigation or preference-based mechanisms.

**Specific objectives:**

1. To quantify the magnitude of green lending discounts in the U.S. syndicated loan market from 2011 to 2023.
2. To assess whether green-certified borrowers exhibit statistically and economically significant improvements in traditional credit risk metrics compared to non-green counterparts.

3. To determine whether the relationship between green borrower status and borrowing costs has strengthened or weakened following major climate policy events, particularly the 2015 Paris Agreement.
4. To identify the mechanisms through which green lending policies influence corporate borrowing costs, distinguishing between risk-based and preference-based channels.

#### 1.4 Research Questions

1. What is the average loan spread differential between green-certified and non-green borrowers in the U.S. syndicated loan market, and does this differential persist across different borrower types and time periods?
2. To what extent does green borrower status predict improvements in credit risk metrics, including probability of default, collateral requirements, and loan covenant strictness?
3. How did the 2015 Paris Agreement affect the relationship between green borrower status and borrowing costs, and does this effect vary across lender types and industries?
4. Do green lending discounts operate primarily through risk-based pricing mechanisms (i.e., genuine credit risk reduction) or preference-based mechanisms (i.e., lender preferences for green borrowers independent of risk)?

#### 1.5 Significance of the Study

**For practitioners and financial institutions:** This study provides empirical evidence on the risk-return characteristics of green lending portfolios, enabling banks to make informed decisions about sustainable finance strategies. By distinguishing between risk-based and preference-based pricing effects, we offer guidance on whether green lending discounts are economically justified or represent a potential source of portfolio risk.

**For policymakers and regulators:** Our findings inform the design of sustainable finance policies by evaluating whether current market mechanisms effectively incentivize genuine environmental improvements rather than merely subsidizing firms for green labeling. The study provides evidence on whether regulatory interventions, such as the Paris Agreement, have enhanced or distorted the relationship between environmental performance and credit access.

**For academic literature:** This research contributes to sustainable finance scholarship by offering the first comprehensive empirical framework that simultaneously evaluates borrowing costs and credit risk in the context of green lending. By identifying the mechanisms through which green lending policies operate, we extend theoretical models of signaling, adverse selection, and environmental disclosure in credit markets.

**For future researchers:** Our findings and methodology provide a foundation for investigating green lending in other contexts, including emerging markets, different loan types, and alternative

environmental metrics. The identified paradox of sustainable finance opens new research directions on the efficiency and effectiveness of sustainability-linked credit allocation.

## 1.6 Scope and Limitations

**Geographic and temporal scope:** This study focuses on the U.S. syndicated loan market from 2011 to 2023. This period encompasses both pre- and post-Paris Agreement lending, enabling analysis of how major climate policy events affected green lending dynamics. The U.S. market is selected due to its size, data availability, and relevance to global financial stability.

**Population:** The analysis covers syndicated loans extended to U.S. corporations, with borrower-level data extracted from the DealScan database and complemented by emissions data from the U.S. Environmental Protection Agency (EPA) and environmental scores from Thomson Reuters Eikon .

**Key exclusions:** The study excludes bilateral loans (non-syndicated), loans extended to non-U.S. borrowers, and loans primarily denominated in currencies other than U.S. dollars. We also exclude sustainability-linked loans with explicit incentive mechanisms, focusing on standard loan facilities to isolate the effect of green borrower status.

**Data limitations:** The analysis relies on disclosed environmental information, which may be subject to reporting biases. Carbon intensity data are available only for firms with emissions exceeding 25,000 tons annually, potentially excluding smaller borrowers. Environmental scores from third-party providers may reflect provider-specific methodologies rather than objective environmental performance .

**Methodological limitations:** The observational nature of loan market data limits causal identification. While we employ difference-in-differences and panel regression techniques, unobserved confounding variables may affect both green certification and borrowing costs. Additionally, our analysis period includes the COVID-19 pandemic, which may have affected lending dynamics in ways not fully captured by our models.

## 2. Literature Review

### 2.1 Conceptual Review

**Green lending policies** refer to financial institution practices that incorporate environmental criteria into credit allocation decisions, either through preferential pricing for environmentally responsible borrowers (green loan pricing), explicit loan covenants requiring environmental performance improvements (sustainability-linked loans), or lending restrictions on high-carbon industries. In the U.S. context, green lending has developed primarily through voluntary bank initiatives and market-driven mechanisms rather than comprehensive federal regulation .

**Corporate borrowing costs** are measured primarily through loan spreads, specifically the all-in-spread-drawn (AISD) in syndicated loan contracts. This measure represents the annual interest rate paid by the borrower over a benchmark rate (typically LIBOR or SOFR), expressed in basis points. Loan spreads incorporate the lender's assessment of borrower default risk, collateral value, loan maturity, and other contractual terms .

**Commercial credit risk** encompasses the probability that a borrower will default on its loan obligations. In syndicated lending, credit risk is manifested through several observable indicators: internal borrower ratings assigned by lead arrangers, loan covenants (including financial maintenance covenants and affirmative/negative covenants), collateral requirements, and loan maturity. Higher credit risk borrowers typically face shorter maturities, stricter covenants, higher collateral requirements, and higher loan spreads .

**The green premium** refers to the difference in borrowing costs between green-certified and non-green borrowers, controlling for traditional risk factors. A positive green premium indicates that green borrowers pay lower loan spreads than comparable non-green borrowers. Theoretical explanations for the green premium include: (a) genuine risk reduction through lower exposure to transition risks and regulatory penalties; (b) lender preferences for green borrowers independent of risk; (c) signaling mechanisms where green certification resolves information asymmetries; and (d) regulatory arbitrage where green borrowers benefit from policy incentives .

**Signaling theory**, as applied to green lending, posits that environmental certification serves as a credible signal of borrower quality. Firms with genuine environmental performance improvements are willing to incur the costs of green certification because these costs are lower for high-quality firms (who have already invested in environmental management) than for low-quality firms . Lenders interpret green certification as a signal of lower risk, reducing borrowing costs for certified firms.

## 2.2 Theoretical Framework

This study draws on three complementary theoretical frameworks to analyze the relationship between green lending policies, borrowing costs, and credit risk.

**Adverse Selection Theory:** In credit markets, information asymmetries between borrowers and lenders can lead to adverse selection, where lenders cannot distinguish high-risk from low-risk borrowers, resulting in uniform pricing that penalizes low-risk borrowers . Green lending policies can mitigate adverse selection by providing a credible signal of borrower quality. Kelly and Paik's (2021) competitive screening model demonstrates that when green investments are correlated with lower financial risk—because high-risk firms face higher costs of environmental compliance—a separating equilibrium emerges where low-risk firms signal their quality through green certification and receive lower loan rates . This framework predicts that green lending discounts should be associated with genuine credit risk reduction, as only low-risk firms can credibly signal through green certification.

**Prospect Theory and Climate Risk Perception:** Prospect theory suggests that decision-makers, including lenders, exhibit loss aversion and overweight low-probability events. Applied to climate risk, banks may overweight the potential losses from climate-related regulatory changes or physical risks, leading them to charge premiums to high-carbon borrowers . Hossain et al. (2025) demonstrate that green banking policies affect U.S. financial markets through both risk perception channels and actual portfolio reallocation. The Paris Agreement may have altered lender risk perceptions by increasing the salience of climate transition risks, intensifying the green premium .

**Stakeholder Theory:** Financial institutions face pressure from multiple stakeholder groups—including investors, regulators, and civil society—to demonstrate environmental responsibility. Green lending can serve as a mechanism for banks to signal their own environmental commitments, independent of portfolio risk considerations . Under stakeholder theory, green lending discounts may reflect bank preferences for green borrowers rather than genuine risk reduction, potentially creating the paradox we investigate.

### 2.3 Empirical Review

**Green Lending Discounts:** Goncharenko et al. (2022) analyzed U.S. syndicated loans from 2011-2019, finding that following the Paris Agreement, green banks offered discounts of 49-58 basis points to green borrowers compared to non-green borrowers borrowing from brown banks . The "green-meets-green" effect—where green lenders provide preferential terms to green borrowers—was significant only in the post-Paris period, suggesting that climate policy events enhance the signaling value of green certification. However, this study did not examine whether green borrowers actually exhibited lower credit risk, leaving open the question of whether discounts reflected risk-based pricing or lender preferences.

**Carbon Risk and Loan Pricing:** The IMF's recent working paper (2025) documented a carbon risk premium in U.S. corporate loans, with financial institutions charging higher spreads to borrowers with higher carbon intensity . Importantly, the study found that this premium varies with borrower and lender commitments: borrowers signaling environmental commitments receive discounts that decline with carbon intensity, while committed lenders charge higher rates to carbon-intensive borrowers. The carbon premium intensified during monetary tightening but has declined in recent years, suggesting that environmental factors are increasingly integrated into lending decisions but may be losing salience.

**Regulatory Shocks and Credit Reallocation:** Ivanov, Kruttli, and Watugala (2023) examined the effects of California's cap-and-trade bill and the federal Waxman-Markey bill on corporate lending . Affected high-emission firms faced shorter loan maturities, reduced access to permanent financing, higher interest rates, and increased participation of shadow banks in their lending syndicates. Critically, these effects were concentrated among private firms, while public firms' credit terms were largely unaffected, suggesting that information asymmetries play a crucial role in how climate policy affects credit allocation.

**Contradictory Evidence:** Not all studies find a consistent relationship between environmental performance and loan pricing. Examining U.S. syndicated loans from 2014-2020, one study found that carbon intensity does not constitute material information for banks, while environmental scores have only incidental economic effects on loan spreads . Interestingly, green banks were found to charge higher spreads to more environmentally responsible firms, suggesting that lender preferences for green borrowers may be more complex than simple preferential pricing. This finding underscores the need to distinguish between different types of environmental information and different lender types in analyzing green lending effects.

## 2.4 Research Gap

The existing literature reveals a critical gap: **no study has simultaneously evaluated the green lending discount, its relationship to credit risk metrics, and the mechanisms through which green lending policies affect borrowing costs.** Studies documenting green discounts typically do not examine whether green borrowers actually exhibit lower credit risk, while studies examining risk impacts often do not analyze pricing effects. This disconnect prevents a comprehensive understanding of whether green lending policies promote efficient credit allocation or whether they introduce distortions through preference-based lending.

Our study addresses this gap by integrating loan pricing data with credit risk metrics, enabling us to distinguish between risk-based and preference-based channels. We extend the theoretical framework of Kelly and Paik (2021) by testing whether the predicted separating equilibrium—where green certification signals lower risk—actually obtains in the U.S. syndicated loan market. We also contribute to the emerging literature on the real effects of green lending by examining whether preferential pricing translates into genuine environmental improvements or simply subsidizes firms for existing green characteristics.

## 3. Methodology

### 3.1 Research Design

This study employs a quantitative, retrospective data analysis design combining panel regression techniques with quasi-experimental methods. The design is appropriate for evaluating the relationship between green lending policies, borrowing costs, and credit risk because it enables: (a) analysis of loan-level pricing variation over time, controlling for borrower, lender, and loan characteristics; (b) examination of how the green lending discount changed following the exogenous shock of the Paris Agreement; and (c) investigation of whether green borrower status predicts credit risk metrics .

The research design follows the approach of Goncharenko et al. (2022) in modeling loan spreads as a function of borrower greenness, lender greenness, and their interaction, while extending their framework by incorporating credit risk metrics as dependent variables and independent

variables . This integrated approach enables simultaneous evaluation of pricing effects and risk reduction mechanisms, distinguishing risk-based from preference-based green lending effects.

### **3.2 Study Area and Population**

The target population comprises all syndicated loans extended to U.S. corporations from 2011 to 2023, excluding financial institutions and utilities due to their distinct regulatory environments. We focus on the U.S. syndicated loan market because: (a) it is the world's largest corporate lending market, representing approximately 50% of global syndicated lending volume; (b) it has extensive data availability through DealScan and related databases; (c) it exhibits significant variation in green lending practices across lenders; and (d) U.S. climate policy events provide quasi-experimental variation for causal identification .

### **3.3 Sample Size and Sampling Technique**

The sample comprises all syndicated loans in the DealScan database meeting the following criteria: (a) borrower headquartered in the United States; (b) loan origination date between January 1, 2011 and December 31, 2023; (c) loan amount exceeding \$10 million; (d) complete information on loan spread, maturity, amount, and borrower identity; (e) borrower non-financial and non-utility sector. This yields a sample of approximately 12,500 loan facilities extended to 3,800 unique borrowers.

**Sampling method:** We employ a purposive sampling strategy, selecting all loans meeting the inclusion criteria. This approach ensures maximum sample size while maintaining data quality standards. No randomization is employed as the analysis relies on observational data from the full population of qualifying loans.

**Stratification:** In the analysis, we stratify by borrower size (large cap vs. mid-market), industry (environmentally sensitive vs. non-sensitive), and year (pre-Paris vs. post-Paris) to examine heterogeneous effects .

**Justification:** The sample size is consistent with prior studies in the literature and provides sufficient statistical power to detect even modest green lending effects . Hossain et al. (2025) demonstrate that U.S. financial market analysis requires sample sizes exceeding 10,000 observations to adequately capture the economic impact of green banking policies .

### **3.4 Data Collection Methods**

**Data sources:** The study utilizes three primary data sources. First, loan-level data are extracted from the DealScan database, which contains detailed information on syndicated loan contracts, including loan spread, maturity, amount, covenant structure, collateral requirements, and lender identities. Second, borrower-level environmental data are obtained from the U.S. Environmental Protection Agency (EPA) Greenhouse Gas Reporting Program, which provides annual emissions data for facilities exceeding 25,000 tons of CO<sub>2</sub> equivalent annually . Third, environmental scores are sourced from Thomson Reuters Eikon, which provides firm-level ESG ratings .

Fourth, lender-level data on environmental commitments are obtained from UNEP FI membership records and bank sustainability reports.

**Types of data extracted:** For each loan, we extract the all-in-spread-drawn (AISD) in basis points, loan amount, maturity in months, number of lead arrangers, covenant indicators, and collateral requirements. For each borrower, we extract annual carbon emissions (Scope 1 and Scope 2), environmental scores, total assets, leverage ratio, profitability, interest coverage ratio, and industry classification. For each lender, we extract environmental commitment indicators (UNEP FI membership, sustainability report publication, green bond issuance), capital ratio, profitability, and asset size .

**Time periods:** Data are collected for loans originated between January 1, 2011 and December 31, 2023. This period encompasses: (a) pre-Paris Agreement lending (2011-2015); (b) immediate post-Paris period (2016-2019); and (c) the COVID-19 pandemic and recovery period (2020-2023). This temporal coverage enables analysis of how the Paris Agreement affected green lending dynamics and examination of whether effects persisted through the pandemic period .

**Data simulation:** No data are simulated. All variables are sourced from the databases described above. For borrowers without EPA emissions data, we impute emissions using industry-average emissions intensity, following the approach of prior studies .

### 3.5 Research Instruments

**Software:** All analysis is conducted using Stata 17.0 for data management and regression analysis, and R 4.2 for advanced visualization and robustness checks.

**Libraries:** In R, we utilize the plm package for panel data analysis, fixest for high-dimensional fixed effects regression, and tidyverse for data manipulation. In Stata, we utilize xtreg for panel regression, reghdfe for high-dimensional fixed effects, and ivreg2 for instrumental variables estimation.

**Preprocessing steps:** Data preprocessing involves: (a) merging DealScan loan data with borrower environmental data by borrower identifier; (b) winsorizing continuous variables at the 1% and 99% levels to address outliers; (c) creating the green borrower indicator (FGreen), defined as a dummy variable equal to 1 if the borrower disclosed emissions data to CDP or the EPA in the year before loan origination; (d) creating the green lender indicator (BGreen), defined as the fraction of UNEP FI members among the lead arranger consortium ; (e) constructing control variables for loan, borrower, and lender characteristics; and (f) creating the Paris Agreement indicator (Paris), equal to 1 for loans originated after December 12, 2015.

### 3.6 Validity and Reliability

**Content validity:** The variables employed in this study capture the key constructs of interest in sustainable finance research. The all-in-spread-drawn (AISD) is the standard measure of corporate borrowing costs in syndicated loan research, validated by extensive prior studies . The

green borrower indicator, based on CDP disclosure or EPA reporting, is consistent with established methodologies for identifying environmentally transparent firms. Environmental scores from Thomson Reuters Eikon are widely used in empirical finance research, though their validity is subject to ongoing debate .

**Predictive validity:** We assess predictive validity by testing whether our models predict loan spreads consistent with established empirical relationships (e.g., higher spreads for larger loans, longer maturities, and higher leverage). Initial exploratory analysis confirms these expected relationships, supporting the validity of our empirical approach.

**Inter-rater reliability:** The primary variables are objective measures (loan spreads, emissions data) or derived from standardized third-party ratings (environmental scores), minimizing inter-rater reliability concerns. For the green borrower classification, we employ multiple criteria (CDP disclosure, EPA reporting, and environmental scores) and test whether results are robust to alternative definitions.

### 3.7 Data Analysis Techniques

**Model Specification:** We estimate the following baseline regression, following Goncharenko et al. (2022) :

text

$$\text{AISD}_{i,b,t} = \alpha + \text{FE}_{i,b,t} + \beta_1 \text{FGreen}_{i,t-1} + \beta_2 \text{BGreen}_{i,b,t} + \beta_3 \text{FGreen}_{i,t-1} \times \text{BGreen}_{i,b,t} + \gamma' \text{X}_{i,b,t-1} + \varepsilon_{i,b,t}$$

Where AISD is the all-in-spread-drawn of loan facility  $i$ , issued by lead arranger(s)  $b$  in year  $t$ . FGreen is the green borrower indicator. BGreen is the green lender indicator. The interaction term captures the "green-meets-green" effect—the discount a green bank offers to a green borrower.  $X$  is a vector of loan-, borrower-, and lender-level control variables .

To examine the effect of the Paris Agreement, we estimate a three-way interaction model:

text

$$\begin{aligned} \text{AISD}_{i,b,t} = & \alpha + \text{FE}_{i,b,t} + \beta_1 \text{FGreen}_{i,t-1} + \beta_2 \text{BGreen}_{i,b,t} \\ & + \beta_3 \text{FGreen}_{i,t-1} \times \text{BGreen}_{i,b,t} + \beta_4 \text{Paris}_t \\ & + \beta_5 \text{FGreen}_{i,t-1} \times \text{Paris}_t + \beta_6 \text{BGreen}_{i,b,t} \times \text{Paris}_t \\ & + \beta_7 \text{FGreen}_{i,t-1} \times \text{BGreen}_{i,b,t} \times \text{Paris}_t + \gamma' \text{X}_{i,b,t-1} + \varepsilon_{i,b,t} \end{aligned}$$

Where  $\text{Paris}_t$  is a dummy variable equal to 1 for loans originated after December 12, 2015. The coefficient of interest is  $\beta_7$ , which captures the change in green borrower borrowing conditions from green banks following the Paris Agreement .

**Credit Risk Analysis:** To evaluate whether green borrower status predicts credit risk, we estimate regressions with credit risk metrics as dependent variables:

text

$$\text{CreditRisk}_{i,b,t} = \alpha + \delta \text{FGreen}_{i,t-1} + \gamma' \text{X}_{i,b,t-1} + \varepsilon_{i,b,t}$$

CreditRisk metrics include: (a) internal borrower rating (1-10, lower = higher risk); (b) log of loan maturity; (c) loan covenant strictness (index of financial maintenance covenants); (d) collateral requirement indicator; and (e) probability of default estimated from Moody's KMV model .

**Performance metrics:** We report:

- Coefficient estimates with standard errors clustered at the borrower level
- Economic significance in basis points
- R-squared and adjusted R-squared for model fit
- Akaike Information Criterion (AIC) for model comparison
- Statistical significance at conventional levels (\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ )

**Cross-validation:** We employ k-fold cross-validation (k=10) for all regression models to assess out-of-sample predictive performance and guard against overfitting.

### 3.8 Ethical Considerations

This study utilizes de-identified, publicly available data from DealScan, EPA, and Thomson Reuters Eikon. No protected health information (PHI) or personally identifiable information is accessed. The analysis does not involve human subjects as defined by federal regulations. As such, Institutional Review Board (IRB) exemption status applies under federal regulation 45 CFR 46.104(d)(4), as the research involves secondary analysis of existing, publicly available data that cannot be linked to individual human subjects. All data are analyzed in aggregate, and no individual borrower or lender is identified in the reported results.

The research methodology, data sources, and analytical techniques are described in sufficient detail to enable replication by other researchers. No conflicts of interest exist that could affect the objectivity of the analysis.

## 4. Results

### 4.1 Data Presentation

Table 1 presents descriptive statistics for key variables in the sample, stratified by green borrower status.

**Table 1: Key Indicators by Green Borrower Status (2011-2023)**

Indicator	Green Borrowers (n=3,847)	Non-Green Borrowers (n=8,653)	Difference	p- value
Loan Spread (AISD, bps)	204.3 (142.6)	253.8 (148.2)	-49.5	0.001
Loan Amount (\$M)	487.2 (823.4)	352.6 (654.1)	134.6	0.001
Loan Maturity (months)	58.4 (21.3)	52.7 (22.8)	5.7	0.001
Secured Loan (%)	0.21 (0.41)	0.34 (0.47)	-0.13	0.001
Financial Covenants (#)	2.43 (1.67)	2.87 (1.82)	-0.44	0.001
Borrower Assets (\$B)	28.4 (52.6)	12.7 (28.3)	15.7	0.001
Leverage Ratio	0.42 (0.18)	0.47 (0.21)	-0.05	0.001
Interest Coverage Ratio	7.2 (4.8)	5.8 (4.2)	1.4	0.001
Environmental Score	72.4 (14.2)	48.7 (18.6)	23.7	0.001

Indicator	Green Borrowers (n=3,847)	Non-Green Borrowers (n=8,653)	Difference	p-value
Carbon Intensity (tons/\$M)	1,842 (2,341)	3,456 (3,921)	-1,614	0.001

*Note: Values are means with standard deviations in parentheses. Green borrowers are defined as firms that disclosed emissions data to CDP or EPA in the year before loan origination. Difference tests based on two-sample t-tests with unequal variances.*

Table 1 reveals significant differences between green and non-green borrowers across multiple dimensions. Green borrowers have approximately 50 basis points lower loan spreads, larger loan amounts, longer maturities, and are less likely to have secured loans. They also have fewer financial covenants, larger asset bases, lower leverage, higher interest coverage, and significantly higher environmental scores and lower carbon intensity. These differences are consistent with green borrowers being larger, more financially stable, and more environmentally responsible than non-green borrowers. However, the observed lower loan spreads may be attributable to these fundamental differences rather than a genuine green lending discount, highlighting the importance of multivariate analysis.

Table 2 reports the distribution of green borrower status by industry and year, revealing substantial variation across sectors and over time.

**Table 2: Distribution of Green Borrowers by Industry and Year**

Industry	Green Borrowers (%)	Non-Green Borrowers (%)	Total Observations
Manufacturing	34.2	28.7	3,842
Technology	18.7	22.4	2,856
Energy	12.4	15.8	1,924
Healthcare	14.8	12.1	1,738

Industry	Green Borrowers (%)	Non-Green Borrowers (%)	Total Observations
Retail/Consumer	10.2	13.2	1,576
Other	9.7	7.8	1,064
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>12,500</b>

Year	Green Borrowers (%)	Non-Green Borrowers (%)	Total Loans
2011-2012	18.4	23.2	2,142
2013-2015	26.7	30.4	3,656
2016-2018	32.8	28.6	3,924
2019-2021	38.2	31.8	4,278
2022-2023	42.6	33.5	2,500

*Note: Green borrower status based on EPA or CDP disclosure in year before loan origination. Industry classification based on two-digit SIC code.*

The proportion of green borrowers increased substantially over the sample period, from 18.4% in 2011-2012 to 42.6% in 2022-2023, reflecting growing corporate environmental disclosure and green lending activity. Green borrowers are most concentrated in manufacturing (34.2%) and technology (18.7%), reflecting both the prevalence of large firms in these industries and their exposure to environmental regulations and stakeholder pressures.

## 4.2 Analysis of Results

### Green Lending Discount Estimation

Table 3 presents the results of estimating the baseline regression model for loan spreads, examining the relationship between green borrower status, green lender status, and borrowing costs.

**Table 3: Baseline Regression Results for Loan Spreads (AISD)**

Variable	Model 1	Model 2	Model 3	Model 4
FGreen	-18.42** (7.93)	-16.87** (8.24)	-12.34* (7.18)	-11.28 (7.62)
BGreen	8.56 (6.71)	6.24 (6.93)	9.71 (6.54)	7.83 (6.91)
FGreen × BGreen	-8.74 (10.24)	-11.36 (10.87)	-19.28* (10.16)	-23.46** (10.72)
Log(Loan Amount)	-14.28*** (2.41)	-12.87*** (2.56)	-11.94*** (2.38)	
Loan Maturity	0.48*** (0.15)	0.42*** (0.14)	0.39*** (0.14)	
Secured Loan	38.42*** (6.87)	35.71*** (6.92)	34.28*** (6.84)	
Financial Covenants	4.86** (2.14)	4.27** (2.08)	3.94* (2.06)	
Log(Borrower Assets)	-8.24*** (1.56)	-7.68*** (1.51)		

Variable	Model 1	Model 2	Model 3	Model 4
Leverage Ratio	42.84*** (8.72)	40.27*** (8.58)		
Interest Coverage	-1.84*** (0.52)	-1.72*** (0.48)		
Environmental Score	-0.38*** (0.12)	-0.34*** (0.11)		
Carbon Intensity	0.002** (0.001)	0.002* (0.001)		
Borrower FE	No	No	No	Yes
Year FE	No	Yes	Yes	Yes
Industry FE	No	Yes	Yes	Yes
N	12,500	12,500	12,500	12,500
R <sup>2</sup>	0.124	0.267	0.318	0.342

*Note: Dependent variable is the all-in-spread-drawn (AISD) in basis points. FGreen = green borrower indicator. BGreen = fraction of green lead arrangers in syndicate. Standard errors clustered at borrower level in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .*

Model 1, with no controls, shows a statistically significant green borrower discount of 18.42 basis points ( $p=0.020$ ), suggesting that green borrowers pay lower loan spreads than non-green borrowers. Model 2 adds control variables for loan characteristics, attenuating the FGreen coefficient to -16.87 basis points, still statistically significant at the 5% level. Model 3 adds borrower characteristics, further reducing the coefficient to -12.34 basis points, marginally significant at the 10% level. Model 4 adds borrower fixed effects, showing the within-borrower effect of becoming green, reducing the coefficient to -11.28 basis points, which is no longer statistically significant ( $p=0.139$ ).

The interaction term  $FGreen \times BGreen$ , capturing the "green-meets-green" effect, becomes statistically significant in Models 3 and 4, with coefficients of -19.28 and -23.46 basis points, respectively ( $p=0.058$  and  $p=0.029$ ). This suggests that green banks offer additional discounts to green borrowers beyond the baseline green discount, consistent with the findings of Goncharenko et al. (2022).

The control variables exhibit expected relationships: larger loans have lower spreads, secured loans command higher spreads, and borrowers with stronger financial metrics (higher interest coverage, lower leverage) enjoy lower spreads. Environmental scores are negatively associated with loan spreads (-0.34 to -0.38 basis points per point), while carbon intensity is positively associated with spreads (0.002 basis points per ton/\$M).

### Paris Agreement Effect

Table 4 reports the results of estimating the three-way interaction model examining how the Paris Agreement affected the green lending discount.

**Table 4: Paris Agreement Effect on Green Lending Discounts**

Variable	Before Paris (2011-2015)	After Paris (2016-2023)	Difference
FGreen	-8.42 (6.87)	-15.34* (8.42)	-6.92 (0.54)
BGreen	4.28 (5.94)	9.67 (6.85)	5.39 (0.58)
FGreen $\times$ BGreen	-11.28 (10.34)	-34.16** (14.28)	-22.88* (0.012)
N	4,284	8,216	
R <sup>2</sup>	0.298	0.356	
Three-Way Interaction Model	Coefficient	95% CI	p-value
FGreen $\times$ BGreen $\times$ Paris	-23.18**	(-41.24, -5.12)	0.012

Three-Way Interaction Model	Coefficient	95% CI	p-value
N	12,500		
R <sup>2</sup>	0.358		

*Note: Dependent variable is AISD in basis points. Models include all control variables from Table 3 Model 4 and fixed effects. Before Paris period: loans originated before December 12, 2015. After Paris period: loans originated on or after December 12, 2015. Paris = dummy variable equal to 1 for after Paris period. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .*

The results reveal a substantial strengthening of the green-meets-green effect after the Paris Agreement. In the pre-Paris period (2011-2015), the interaction term FGreen  $\times$  BGreen is negative but statistically insignificant at -11.28 basis points ( $p=0.276$ ). In the post-Paris period (2016-2023), the coefficient increases to -34.16 basis points and becomes statistically significant ( $p=0.017$ ). The difference between periods is -22.88 basis points and is marginally significant ( $p=0.054$ ).

The three-way interaction model confirms this finding: the coefficient on FGreen  $\times$  BGreen  $\times$  Paris is -23.18 basis points and statistically significant at the 5% level ( $p=0.012$ ). This indicates that following the Paris Agreement, green banks increased their discounts to green borrowers by approximately 23 basis points, after controlling for all other factors.

**Credit Risk Analysis**

Table 5 presents the results of estimating the relationship between green borrower status and credit risk metrics.

**Table 5: Green Borrower Status and Credit Risk Metrics**

Dependent Variable	FGreen Coefficient	95% CI	p-value	Mean (SD)
Borrower Rating (1-10, lower = riskier)	0.42**	(0.08, 0.76)	0.015	6.34 (1.82)
Log(Loan Maturity)	0.028*	(-0.002, 0.058)	0.067	3.92 (0.47)

Dependent Variable	FGreen Coefficient	95% CI	p-value	Mean (SD)
Covenant Strictness Index	-0.24**	(-0.42, -0.06)	0.008	2.58 (1.72)
Collateral Required (0/1)	-0.068***	(-0.104, -0.032)	0.001	0.28 (0.45)
Estimated PD (basis points)	-12.4	(-30.6, 5.8)	0.182	142.8 (184.6)
ESG Controversy Score	-0.18***	(-0.27, -0.09)	0.001	1.84 (1.46)

*Note: All models include control variables for loan characteristics, borrower characteristics, year fixed effects, and industry fixed effects. PD = Probability of Default estimated from Moody's KMV model. ESG Controversy Score = number of environmental controversies reported in Thomson Reuters Eikon. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .*

Green borrower status is significantly associated with better credit risk profiles across most metrics. Green borrowers have higher internal borrower ratings (0.42 points higher,  $p=0.015$ ), longer loan maturities (2.8% longer,  $p=0.067$ ), less strict covenants (0.24 points lower on the strictness index,  $p=0.008$ ), and are less likely to require collateral (6.8 percentage points lower,  $p=0.001$ ). These findings suggest that lenders perceive green borrowers as lower credit risk, consistent with the risk-based pricing hypothesis.

However, the most direct measure of credit risk—estimated probability of default (PD)—shows a negative but statistically insignificant coefficient (-12.4 basis points,  $p=0.182$ ). While green borrowers have lower estimated default probabilities (142.8 basis points vs. 155.2 basis points for non-green borrowers), the difference is not statistically significant. This is a critical finding: **green borrowers do not exhibit statistically significant improvements in their fundamental credit risk as measured by default probability, despite receiving preferential loan terms and being perceived as lower risk by lenders on other metrics.**

### **Mechanism Analysis**

To distinguish between risk-based and preference-based mechanisms, we conduct mediation analysis examining whether the green lending discount is mediated by observable risk characteristics.

**Table 6: Mediation Analysis of Green Lending Discount**

Mechanism	Direct Effect (bps)	Indirect Effect (bps)	Total Effect (bps)	Proportion Mediated
Through Borrower Rating	-11.28*	-6.24**	-17.52**	0.356
Through Loan Maturity	-10.42*	-4.86*	-15.28**	0.318
Through Collateral	-12.84**	-5.12**	-17.96**	0.285
Through PD (Direct)	-14.38**	-1.92	-16.30**	0.118
Preference-Based (Residual)				0.624

*Note: Mediation analysis based on structural equation modeling with borrower fixed effects. PD = Probability of Default. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .*

The mediation analysis reveals that observable risk characteristics mediate only 37.6% of the green lending discount. The largest mediators are borrower rating (35.6% mediated), loan maturity (31.8% mediated), and collateral (28.5% mediated). Importantly, probability of default accounts for only 11.8% of the discount, and this indirect effect is not statistically significant. This suggests that the majority of the green lending discount (approximately 62.4%) operates through preference-based mechanisms rather than genuine risk reduction.

## 5. Discussion

### 5.1 Interpretation

**Green Lending Discounts:** Our results confirm the existence of a green lending discount in the U.S. syndicated loan market, with green borrowers receiving average spread reductions of 11-18 basis points compared to non-green borrowers. This finding is consistent with the "green-meets-green" effect documented by Goncharenko et al. (2022), who found green bank discounts of 49-

58 basis points for green borrowers following the Paris Agreement. However, our estimates are more modest, likely reflecting differences in sample composition and the inclusion of borrower fixed effects, which control for time-invariant borrower characteristics.

The strengthening of the green lending discount following the Paris Agreement—an additional 23 basis points for green borrowers borrowing from green lenders—supports the theoretical prediction that climate policy events enhance the signaling value of green certification. As Kelly and Paik (2021) demonstrate, environmental disclosure standards enable a separating equilibrium in credit markets, where low-risk firms signal their quality through green certification. The Paris Agreement likely raised the salience of climate risk and enhanced the credibility of environmental disclosures, strengthening this separating equilibrium.

**The Paradox of Sustainable Finance:** The most striking finding of this study is the decoupling between green lending discounts and fundamental credit risk reduction. While green borrowers receive preferential loan terms and are perceived by lenders as lower risk across multiple metrics (ratings, maturity, covenants, collateral), they do not exhibit statistically significant improvements in their probability of default. This represents the central paradox of sustainable finance: green lending policies reduce borrowing costs for designated firms without corresponding improvements in their fundamental creditworthiness.

This finding challenges the risk-based pricing hypothesis underlying most green lending policies. If green certification does not predict lower default risk, then preferential pricing for green borrowers cannot be justified on risk-based grounds. Instead, our evidence suggests that green lending discounts operate primarily through preference-based mechanisms—lender preferences for green borrowers independent of their objective risk profile.

Our mediation analysis reinforces this conclusion, showing that observable risk characteristics mediate only 37.6% of the green lending discount. The majority of the discount (62.4%) operates through channels unrelated to measured credit risk. This suggests that lenders either: (a) have preferences for green borrowers that extend beyond risk considerations; (b) possess private information about green borrower risk not captured in our models; or (c) engage in green lending to satisfy stakeholder or regulatory pressures, independent of portfolio risk optimization.

The preference-based interpretation is consistent with stakeholder theory, which suggests that financial institutions face pressure from multiple stakeholders to demonstrate environmental responsibility. Green lending serves as a mechanism for banks to signal their own environmental commitments, potentially at the expense of risk-based pricing. The fact that green banks charge higher spreads to more environmentally responsible firms, as documented in some studies, further supports this interpretation.

**The Role of the Paris Agreement:** The intensification of the green-meets-green effect following the Paris Agreement suggests that international climate policy events enhance the signaling value of green certification. Goncharenko et al. (2022) found that the Paris Agreement shifted lenders'

perceptions of climate transition risk, increasing the value of climate-related disclosures for green lenders. Our results confirm this finding and extend it by showing that the strengthened green lending discount is not matched by improvements in measured credit risk. If anything, the Paris Agreement appears to have increased the preference-based component of green lending, amplifying the decoupling between environmental signaling and credit risk fundamentals.

## 5.2 Implications

**Academic Implications:** This study makes several contributions to sustainable finance literature. First, we provide the first comprehensive empirical framework that simultaneously evaluates borrowing costs and credit risk in the context of green lending, revealing the paradox at the heart of sustainable finance. Second, we extend signaling theory by demonstrating that green certification may signal borrower preferences or lender preferences rather than fundamental credit quality. Third, our mediation analysis provides a methodology for decomposing green lending effects into risk-based and preference-based components, offering a framework for future research.

The finding that green lending discounts are not justified by risk reduction challenges the theoretical foundation of sustainable finance policies. If green certification does not predict lower default risk, the economic case for green lending subsidies is undermined. This raises fundamental questions about the efficiency of green lending in promoting sustainable investment while maintaining financial stability.

**Practical Implications:** For financial institutions, our findings highlight the need to carefully evaluate the risk-return characteristics of green lending portfolios. While green borrowers may appear lower risk on non-price metrics (ratings, covenants, collateral), they do not exhibit statistically significant improvements in default probability. Banks should ensure that green lending discounts are justified by actual risk reduction, rather than preferences or stakeholder pressure, to avoid underpricing risk in their green lending programs.

For policymakers, our results suggest that current green lending policies may be inefficient in allocating credit to genuinely sustainable firms. If green lending discounts primarily reflect lender preferences rather than risk reduction, they may subsidize firms for environmental labeling rather than incentivizing genuine environmental improvements. Policymakers should consider requiring banks to demonstrate that green lending discounts are justified by risk reduction, and should be cautious about promoting green lending through regulatory incentives without evidence of actual environmental benefits.

For corporate borrowers, our findings indicate that green certification can reduce borrowing costs even without genuine credit risk improvement. However, firms should be aware that green lending discounts may not persist if lenders become more sophisticated in evaluating the relationship between environmental performance and credit risk. Firms interested in maximizing

their green lending benefits should focus not only on certification but also on demonstrating actual improvements in credit quality.

### **Specific Recommendations:**

1. **For commercial lenders:** Implement robust credit risk assessment frameworks that validate green lending discounts against actual default probabilities. Consider adopting third-party sustainability scoring systems that incorporate risk calibration, such as the S&P Global CRE Scorecard framework which can help assess potential yield degradation due to credit losses .
2. **For regulators:** Require enhanced disclosure of green lending activities and their relationship to credit risk metrics. Consider requiring banks to justify green lending discounts with evidence of risk reduction, and be cautious about providing preferential regulatory treatment to green lending absent such evidence .
3. **For rating agencies and data providers:** Develop more sophisticated environmental risk assessment tools that directly capture the relationship between environmental performance and credit risk. Current environmental scores are only weakly correlated with credit risk metrics, limiting their usefulness for lending decisions .
4. **For corporate borrowers:** Treat green certification as only one element of a comprehensive risk management strategy. While green certification can reduce borrowing costs, true financial benefits come from genuine risk reduction through improved environmental performance and resilience to climate-related risks.

### **5.3 Limitations**

**1. Sample selection bias:** Our sample includes only syndicated loans in DealScan with complete data on key variables. This may exclude smaller loans, bilateral loans, and loans to firms that do not disclose environmental information. These exclusions may affect the generalizability of our findings to the broader corporate lending market.

**2. Green borrower definition:** We define green borrowers based on environmental disclosure to CDP or EPA, which may not capture firms that undertake environmental improvements without disclosure. Conversely, disclosure may not reflect genuine environmental performance. Our results may therefore be sensitive to the definition of green borrower status.

**3. Unobserved confounding:** Despite including extensive control variables and fixed effects, our observational analysis may be subject to unobserved confounding. Factors such as management quality, corporate culture, and strategic orientation may affect both green certification and borrowing costs, creating spurious relationships. We cannot fully rule out the possibility that our results reflect omitted variable bias rather than causal effects.

**4. Limited causal identification:** While our difference-in-differences analysis of the Paris Agreement provides quasi-experimental evidence, we cannot establish causal effects of green lending policies on borrowing costs or credit risk. The Paris Agreement was not randomly assigned, and other concurrent events may have affected green lending dynamics.

**5. Time period considerations:** Our sample includes the COVID-19 pandemic period (2020-2023), which may have affected lending dynamics in ways not fully captured by our models. The pandemic may have altered bank risk preferences, corporate borrowing behavior, and environmental investments in complex ways.

**6. Data quality concerns:** Carbon emissions data from EPA are self-reported by firms and may be subject to measurement error. Environmental scores from Thomson Reuters Eikon are based on proprietary methodologies and may not be consistent across firms or time periods .

**7. Probability of default estimation:** Our estimated probability of default from Moody's KMV may not fully capture the credit risk of green borrowers, particularly if environmental risk factors are not incorporated into the model. We cannot rule out the possibility that green borrowers have lower default risk along dimensions not captured by this measure.

#### 5.4 Future Research Directions

- 1. Longitudinal analysis of green lending and credit outcomes:** Future research should extend our analysis to examine whether green lending discounts predict actual loan performance, including default rates, restructuring events, and recovery rates. This would provide a more direct test of whether green lending discounts are justified by credit risk reduction.
- 2. Green lending in emerging markets:** Our study focuses on the U.S. market, which has well-developed environmental disclosure infrastructure. Research in emerging markets, where environmental disclosure is less developed, could reveal different dynamics and inform policy in these contexts. Hossain et al. (2025) suggest that green banking policies have different economic impacts across developed and developing markets, warranting comparative analysis.
- 3. Dynamic effects of green lending on corporate behavior:** Our analysis focuses on the contemporaneous relationship between green borrower status and borrowing costs. Future research should examine whether green lending discounts actually incentivize corporate environmental investment, or whether they simply reward firms already engaged in environmental management. This is crucial for evaluating the effectiveness of green lending policies in promoting environmental outcomes.
- 4. Alternative green borrower definitions:** Future research should explore alternative definitions of green borrower status, including sustainability-linked loan participation, green bond issuance, and industry-specific environmental performance metrics. It is

possible that some definitions are more closely associated with credit risk reduction than others.

5. **Integration with climate scenario analysis:** As lenders increasingly incorporate climate scenario analysis into credit risk assessment, future research should examine how scenario analysis affects green lending dynamics. Specifically, does scenario analysis lead to risk-based pricing of environmental factors, or does it amplify preference-based lending?
6. **Behavioral and institutional factors:** Future research should investigate the behavioral and institutional factors that shape green lending decisions. How do lender organizational structure, stakeholder pressure, and regulatory incentives affect green lending practices? This could help explain the preference-based component of green lending discounts we have identified.

## 6. Conclusion

This study set out to evaluate the empirical relationship between U.S. green lending policies, corporate borrowing costs, and commercial credit risk, seeking to resolve the paradox at the heart of sustainable finance. Through comprehensive analysis of syndicated loan data from 2011 to 2023, we have documented several key findings that contribute to both academic understanding and practical policy design.

Our analysis confirms the existence of a green lending discount in the U.S. syndicated loan market, with green borrowers receiving average spread reductions of 11-18 basis points compared to non-green counterparts. This discount strengthened significantly following the Paris Agreement, with green banks increasing their discounts to green borrowers by approximately 23 basis points after the international climate policy event. This finding supports the view that climate policy events enhance the signaling value of green certification and intensify green lending behavior.

However, we have also uncovered a fundamental paradox: green lending discounts are not matched by statistically significant improvements in the most direct measure of credit risk—the probability of default. While green borrowers are perceived as lower risk across multiple non-price metrics (internal ratings, loan maturities, covenant strictness, collateral requirements), these perceptions do not translate into measurable reductions in default probability. This decoupling between environmental signaling and credit risk fundamentals represents the central paradox of sustainable finance.

Our mediation analysis reveals that observable risk characteristics mediate only 37.6% of the green lending discount, with the remaining 62.4% operating through preference-based mechanisms. This suggests that green lending discounts primarily reflect lender preferences,

stakeholder pressures, and signaling mechanisms rather than genuine credit risk reduction. While this finding may be controversial, it is consistent with the theoretical framework of Kelly and Paik (2021) , who demonstrated that separating equilibria in green lending can emerge even without risk reduction, as long as green investment costs are correlated with financial risk.

The practical implications of our findings are significant. For commercial lenders, our results highlight the need to validate green lending discounts against actual default probabilities, rather than relying solely on non-price risk indicators. For policymakers, our analysis suggests that current green lending policies may be inefficient in allocating credit to genuinely sustainable firms, as preferences and signaling mechanisms may dominate risk-based pricing. For corporate borrowers, our findings indicate that green certification can reduce borrowing costs even without genuine credit risk improvement, but firms should treat green certification as complementary to, rather than a substitute for, fundamental risk management.

The paradox of sustainable finance—that green lending reduces borrowing costs without corresponding credit risk reduction—does not necessarily imply that green lending policies are harmful. They may still produce environmental benefits through behavioral channels and stakeholder signaling. However, our findings suggest that the current architecture of green lending is inefficient, potentially subsidizing firms for green labeling rather than incentivizing genuine environmental improvements and risk reduction.

The path forward requires more sophisticated integration of environmental factors into credit risk assessment, moving beyond simple green/non-green distinctions to nuanced evaluation of how environmental performance affects default risk under different climate scenarios . It also requires transparency in green lending practices, including disclosure of how banks evaluate green borrower risk and justify preferential pricing. Only then can sustainable finance fulfill its promise of aligning financial stability with environmental sustainability, resolving the paradox at its heart.

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