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Do sustainable loans deliver? Evidence from the syndicated loan market

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ABSTRACT

We study whether sustainable syndicated loans lead to measurable environmental improvements at the firm level. Using a sample of syndicated loans issued between 2018 and 2022, we track borrowers' CO_2 emissions and environmental outcomes over one-, two-, and three-year horizons after loan issuance. We implement dynamic difference-in-differences (DiD) models and complement baseline estimates with propensity-score matched DiD (PSM-DiD). We also collect deal descriptions for sustainability-linked loans (SLLs) to identify whether contracts disclose measurable environmental KPIs (High Transparency) and test whether SLL effects vary with KPI transparency. We find that green loans are associated with large reductions in CO_2 emissions over longer horizons. Average effects for SLLs are weaker, but SLLs with high KPI transparency exhibit stronger improvements in environmental ratings over time.

1. Introduction

The rapid expansion of sustainable finance has placed increasing emphasis on aligning corporate funding with environmental objectives. Among the instruments gaining prominence in this space are green loans and sustainability-linked loans (SLLs). Green loans are designed to finance projects with clearly identifiable environmental benefits—such as renewable energy investments, pollution abatement, or energy efficiency improvements—while SLLs link loan pricing to the borrower's performance on predefined environmental, social, and governance (ESG) indicators (Tang and Zhang, 2020). These instruments have become particularly relevant within the syndicated loan market, where large-scale financing, repeated lender–borrower interactions, and monitoring mechanisms play a central role (Dennis and Mullineaux, 2000).

Despite their rapid growth, an important question remains insufficiently understood: do sustainable lending instruments lead to measurable improvements in firms' environmental performance? While both green loans and sustainability-linked loans aim to align financial incentives with sustainability objectives, they rely on fundamentally different contractual mechanisms. Green loans impose ex ante restrictions on the use of proceeds, whereas SLLs rely on ex post performance-based incentives. Whether these differences translate into distinct environmental outcomes—and over what time horizon—remains an open empirical question.

This issue is particularly salient in the context of increasing expectations placed on financial institutions to support the transition toward a low-carbon economy. Policymakers, investors, and civil society increasingly expect sustainable finance to generate real environmental improvements rather than symbolic compliance. As a result, understanding not only whether sustainable lending matters, but also how different contractual designs shape environmental outcomes, has become a central concern.

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A growing literature has examined the role of green finance in shaping corporate behavior. Early contributions emphasize its potential to internalize environmental externalities and promote sustainable investment (Porter and Van der Linde, 1995; Fatemi and Fooladi, 2013). Subsequent work conceptualizes green finance as a broader system of instruments and incentives supporting environmental transitions (Lagoarde-Segot, 2019; Cui et al., 2020; Khan et al., 2022; Kumar et al., 2022; Tao et al., 2022). Empirical evidence, however, remains mixed. Some studies document reductions in emissions or improvements in environmental performance following green financial interventions (Karim et al., 2022; Wan et al., 2022), while others find limited or context-dependent effects, often shaped by institutional or regulatory environments (Rasoulinezhad and Taghizadeh-Hesary, 2022; Pang et al., 2022; Zhuang and Wei, 2022).

Within the syndicated loan market, environmental considerations increasingly affect lending relationships. Firms with stronger ESG profiles tend to obtain more favorable loan terms, while weaker environmental performance is often associated with higher borrowing costs (Carnevale and Drago, 2024). Sustainability-linked loans, in particular, have attracted growing attention as a flexible contractual instrument linking financing conditions to sustainability performance. Existing evidence suggests that SLLs are more likely to be extended to firms with stronger ESG characteristics, although the economic magnitude and effectiveness of these incentives appear to vary across settings and contractual designs (Aleszczyk et al., 2022; Carrizosa and Ghosh, 2023).

Recent work by Kim et al. (2025) highlights that the effectiveness of sustainability-linked loans depends on the transparency of the underlying ESG targets. They show that clearer and more verifiable targets are associated with stronger ESG-related outcomes, including environmental performance measures such as emissions. While this evidence provides important insights into the functioning of sustainability-linked loans, it focuses on a specific contractual setting and does not directly compare SLLs with green loans, which rely on a different use-of-proceeds structure. Moreover, existing evidence remains limited regarding how different forms of sustainable lending affect post-loan environmental outcomes over time.

This paper addresses these gaps by examining the environmental effects of green loans and sustainability-linked loans within the syndicated loan market. We study how these instruments are associated with changes in firms' CO_2 emissions and environmental (E) scores over one-, two-, and three-year horizons following loan issuance. Our empirical approach allows us to compare the dynamics of environmental outcomes across different types of sustainable loans and to assess whether contractual design shapes the timing and magnitude of observed effects.

Our analysis combines a difference-in-differences framework and propensity score matching to address non-random selection into sustainable lending. This approach enables us to compare otherwise similar firms receiving different types of loans and to trace the evolution of environmental outcomes following loan origination. In addition, we exploit variation in the transparency of environmental key performance indicators within sustainability-linked loans to examine how contractual clarity relates to observed environmental outcomes.

Overall, our findings indicate that sustainable lending instruments differ meaningfully in their environmental implications. While green loans are associated with relatively immediate changes in environmental outcomes, the effects of sustainability-linked loans tend to emerge more gradually and vary with the transparency of contractual targets. These patterns highlight the importance of contractual design in shaping the effectiveness of sustainable finance and underscore that not all sustainable lending instruments operate through the same channels.

The remainder of the paper is organized as follows. Section 2 describes the data and empirical methodology. Section 3 presents the main empirical results. Section 4 concludes.

2. Research design

2.1. Data

This study leverages a panel of syndicated loans obtained from LSEG Workspace, covering the period 2018–2022. The final estimation sample varies across specifications due to data availability, the construction of post-origination outcome variables, and the matching procedures implemented in the empirical analysis. The dataset allows us to examine whether green and sustainability-linked loans are associated with measurable improvements in firms' environmental performance.

The outcome variables are measured in levels and capture firms' environmental performance one, two, and three years after loan origination. Specifically, we consider total CO_2 emissions and the Environmental (E) score. CO_2 emissions are measured in absolute terms, while E scores range from 0 to 100, with higher values indicating stronger environmental performance.

Loans are classified into three mutually exclusive categories: traditional loans, green loans, and sustainability-linked loans (SLLs). In addition, for SLLs we manually collect detailed information from loan documentation to identify whether contracts include clearly specified and measurable environmental key performance indicators (KPIs). Based on this information, we construct a binary indicator, *High Transparency*, which equals one when environmental KPIs are explicit, quantifiable, and verifiable, and zero otherwise. This allows us to assess whether the effectiveness of sustainability-linked loans depends on the transparency and credibility of their contractual design.

Control variables include firm size (total assets), leverage (total debt), profitability (return on assets), financial constraints (KZ index), growth opportunities (market-to-book ratio), and risk (stock return volatility). We also include loan-level characteristics

Table 1
Variables description.

Variable	Description	Source
Dependent variables		
GHG (CO_2) emissions	Borrower CO_2 (GHG) emissions measured in year $t+\tau$ after loan issuance ($\tau = 1, 2, 3$).	LSEG Workspace
Environmental score	Borrower Environmental Score measured in year $t+\tau$ after loan issuance ($\tau = 1, 2, 3$).	LSEG Workspace
Independent variables		
Loan category	Classifies the loan as conventional, green, or sustainability-linked.	LSEG Workspace
High transparency	Indicator for SLLs with measurable environmental KPI disclosure in deal descriptions.	Deal descriptions
Control variables		
Brown sector	Indicates whether the borrower operates in a high-carbon (brown) industry.	LSEG Workspace
Total facility amount	Total syndicated loan amount committed to the borrower.	LSEG Workspace
Total assets	Total value of the borrower's assets.	LSEG Workspace
Total debt	Total outstanding debt of the borrower.	LSEG Workspace
ROA	Return on Assets ratio of the borrowing firm.	LSEG Workspace
KZ index	Kaplan–Zingales index (financial constraints).	Computed
Market-to-Book	Proxy for growth opportunities.	Computed
Volatility	Return volatility (risk proxy).	Computed
Covenant-Lite agreement	Flags loans with fewer financial covenants.	LSEG Workspace
Credit rating	Moody's long-term credit rating (or NR).	LSEG Workspace
Yield type	Indicates the loan's risk category.	LSEG Workspace

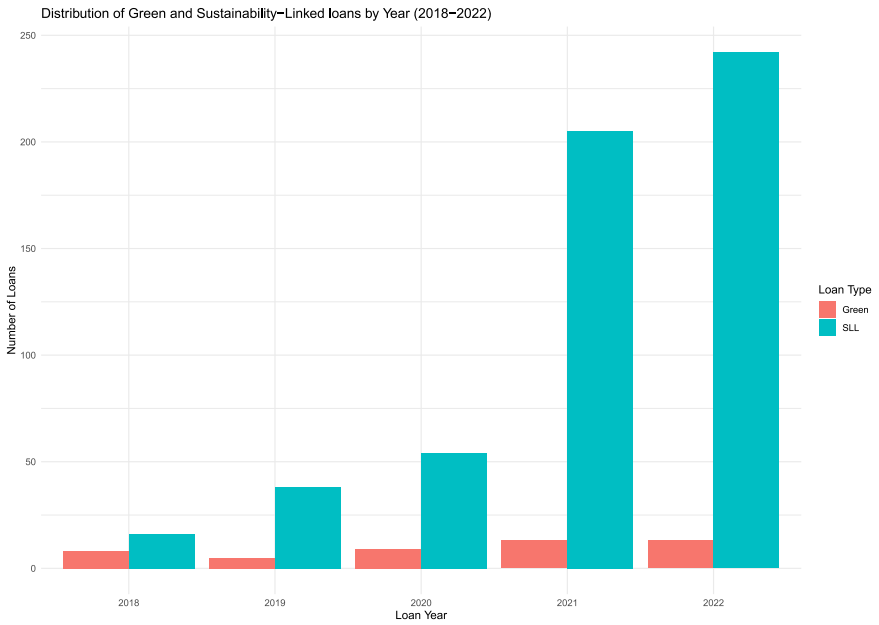


Fig. 1. Distribution of green and SLL loans by year (2018–2022).
Notes: The figure shows the number of green and sustainability-linked loans (SLLs) issued annually from 2018 to 2022. While green loan issuance remained relatively stable, the growth of SLLs accelerated sharply starting in 2021, reflecting their rapid adoption in the syndicated loan market.

such as facility amount, yield type, covenant-lite status, and credit rating. These controls capture differences in firm fundamentals, financing conditions, and risk profiles that may affect both loan selection and environmental outcomes.

A detailed description of all variables is provided in Table 1.

Table 2 reports descriptive statistics for the main variables. Panel A summarizes categorical loan characteristics, while Panel B presents continuous firm- and loan-level characteristics. Green loans represent a small fraction of total lending activity, while sustainability-linked loans account for a larger but still limited share of the sample. This distribution motivates careful attention to comparability across treatment groups.

Fig. 1 plots the annual distribution of green and sustainability-linked loans between 2018 and 2022. While green lending remains relatively stable, the issuance of sustainability-linked loans accelerates sharply in the later years of the sample.

Table 2
Descriptive statistics.

Panel A. Categorical variables			
Variable	Level	N (Model)	%
Loan category			
	Green	30	0.8
	Sustainability-Linked	196	5.1
	Traditional	3633	94.1
High transparency (SLL)			
	0	152	77.5
	1	44	22.5
Brown sector			
	0	3341	86.6
	1	518	13.4
Covenant-Lite agreement			
	0	2741	71.0
	1	1118	29.0
Credit rating			
	A	540	14.0
	AA	111	2.9
	AAA	16	0.4
	B	142	3.7
	BB	441	11.4
	BBB	1089	28.2
	CCC	10	0.3
	NR	1510	39.1
Yield type			
	Highly leveraged	76	2.0
	Investment grade	2628	68.1
	Leveraged	725	18.8
	Near investment grade	16	0.4
	Undisclosed yield type	414	10.7

Panel B. Continuous variables						
Variable	N	Mean	SD	Median	Min	Max
Total facility amount	3859	2131.30	2862.36	1000.00	100.00	14 253.10
Total assets	3859	31 050.42	51 523.11	8682.50	258.35	264 915.62
Total debt	3859	9663.41	15 890.09	2822.80	56.22	77 532.88
ROA	3859	6.45	4.89	5.19	0.32	25.00
KZ index	3859	0.17	15.14	0.27	−122.52	94.92
Market-to-Book	3859	4.58	6.61	2.53	0.19	44.16
Volatility	3859	0.32	0.21	0.26	0.08	1.52

Notes: Panel A reports descriptive statistics for categorical explanatory variables based on the estimation sample. Panel B summarizes continuous variables used in the models, including central tendency and dispersion metrics.

2.2. Empirical strategy

To assess the impact of sustainable lending on firms' environmental outcomes, we estimate dynamic difference-in-differences (DiD) models that compare post-origination outcomes across loan types over multiple horizons. The baseline specification is:

$$Y_{i,t+\tau} = \alpha + \sum_{\tau=1}^{3}\left[\beta_\tau^G\left(Post_\tau \times Green_{i,t}\right) + \beta_\tau^S\left(Post_\tau \times SLL_{i,t}\right) + \beta_\tau^{HT}\left(Post_\tau \times SLL_{i,t} \times HighTransparency_i\right)\right] + \gamma' X_{i,t} + \lambda_b + \eta_{k(i)} + \delta_t + \varepsilon_{i,t+\tau}, \quad (1)$$

where $Y_{i,t+\tau}$ denotes the level of the environmental outcome (GHG emissions or Environmental Score) for firm i measured $\tau \in \{1,2,3\}$ years after loan origination in year t. $Post_\tau$ is an indicator equal to one for outcomes measured at horizon $t+\tau$. $Green_{i,t}$ and $SLL_{i,t}$ indicate that firm i receives a green loan or a sustainability-linked loan in year t, respectively, with conventional loans serving as the reference category. The triple interaction term captures whether SLL effects vary with the transparency and measurability of environmental KPIs disclosed in the contract.

The vector $X_{i,t}$ includes firm and loan controls measured at origination. All specifications include lead-bank fixed effects (λ_b), industry fixed effects ($\eta_{k(i)}$), and year fixed effects (δ_t).

Standard errors are clustered at the industry–year level to account for correlated shocks affecting firms operating within the same sector and year. Identification therefore relies on within-industry, within-bank, and within-year variation in loan type, conditional on observable firm and loan characteristics.

Table 3
DiD estimates for GHG emissions.

Dependent Variable:	GHG emissions	
Model:	(1)	(2)
Variables		
$Post_{t+1}$ × Green	−0.654*	−0.656*
	(0.384)	(0.385)
$Post_{t+2}$ × Green	−6.97**	−6.97**
	(2.94)	(2.94)
$Post_{t+3}$ × Green	−12.1**	−12.1**
	(4.72)	(4.72)
$Post_{t+1}$ × SLL	0.132	0.156
	(0.148)	(0.150)
$Post_{t+2}$ × SLL	−0.465	−0.513
	(0.409)	(0.441)
$Post_{t+3}$ × SLL	−1.67	−1.68
	(1.08)	(1.08)
$Post_{t+1}$ × SLL × High transparency		−0.173
		(0.123)
$Post_{t+2}$ × SLL × High transparency		0.462
		(0.375)
$Post_{t+3}$ × SLL × High transparency		1.36
		(0.822)
Other interactions	Yes	Yes
Lead-bank FE	Yes	Yes
Industry FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
SE clustered by Industry/Year	Yes	Yes
Observations	3859	3859
R^2	0.14147	0.14151

Clustered standard-errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Notes: The dependent variable is borrower GHG (CO_2) emissions measured in year $t+\tau$, with Post(τ) indicating $\tau \in \{1, 2, 3\}$. "Green" and "SLL" are indicator variables for green and sustainability-linked loans, respectively. High transparency equals one if KPI Environmental disclosure is classified as high, and zero otherwise. Firm controls include total assets, total debt, ROA, financial constraints (KZ), market-to-book, volatility and brown-sector indicator. Loan controls include facility amount, yield type, covenant-lite indicator and credit rating. All specifications include lead-bank fixed effects, one-digit industry fixed effects, and year fixed effects. Standard errors are clustered by industry and year. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

To further address selection concerns, we implement a two-stage propensity score matching procedure based on nearest-neighbor matching without replacement. Matching is conducted in two stages. First, green-loan borrowers are matched to sustainability-linked loan borrowers using pre-treatment firm characteristics, including size, profitability, leverage, industry, and issuance year. Second, the combined group of green and sustainability-linked borrowers is matched to firms issuing traditional loans using the same set of covariates. This procedure improves comparability across treatment groups prior to loan issuance.

Treatment effects are then estimated using weighted DiD regressions in which post-treatment indicators are interacted with loan-type dummies. This approach allows us to assess whether environmental outcomes differ systematically across loan types after accounting for observable firm characteristics and pre-existing differences.

While our empirical strategy exploits variation in loan type and timing, loan choice is not random and the design should not be interpreted as a natural experiment. To mitigate selection concerns, we combine rich firm- and loan-level controls with fixed effects and a two-stage propensity score matching procedure. Nevertheless, our results should be interpreted as documenting systematic differences in post-loan environmental outcomes rather than strictly causal effects. The dynamic patterns we document—particularly for sustainability-linked loans—are consistent with meaningful post-origination adjustments rather than purely static selection.

3. Empirical findings

This section presents the main evidence on whether sustainable loans are associated with changes in firms' environmental performance after origination. We first discuss the baseline difference-in-differences estimates on CO_2 emissions and the Environmental score, and then report the corresponding results obtained using the propensity score matching DiD approach. Finally, we document covariate balance achieved through the two-stage matching procedure.

3.1. CO_2 emissions

Table 3 reports DiD estimates for firms' CO_2 emissions measured in levels at horizons $t+1$, $t+2$, and $t+3$ after loan origination. Green loans are associated with economically large and statistically significant emission reductions at longer horizons. In particular, the coefficient for $Post_{t+1}\times Green$ is negative and significant, and the magnitude becomes larger at $Post_{t+2}\times Green$ and $Post_{t+3}\times Green$, indicating that emission reductions accumulate over time. In contrast, the coefficients for sustainability-linked loans (Post(τ) × SLL)

Table 4
PSM-DiD estimates for GHG emissions.

Dependent Variable:	GHG emissions	
Model:	(1)	(2)
Variables		
$Post_{t+1}$ × Green	0.430	0.469
	(0.682)	(0.684)
$Post_{t+2}$ × Green	−8.03**	−8.02**
	(3.15)	(3.15)
$Post_{t+3}$ × Green	−14.9***	−14.9***
	(3.85)	(3.82)
$Post_{t+1}$ × SLL	0.521	0.088
	(0.660)	(0.350)
$Post_{t+2}$ × SLL	0.545	0.357
	(0.625)	(0.368)
$Post_{t+3}$ × SLL	0.238	0.080
	(0.647)	(0.585)
$Post_{t+1}$ × SLL × High transparency		1.06
		(0.888)
$Post_{t+2}$ × SLL × High transparency		0.555
		(0.729)
$Post_{t+3}$ × SLL × High transparency		0.921
		(0.730)
Other interactions	Yes	Yes
Lead-bank FE	Yes	Yes
Industry FE (1-digit)	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
SE clustered by Industry/Year	Yes	Yes
Observations	468	468
R^2	0.87358	0.87443

Clustered standard-errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Notes: The sample is the integrated matched sample obtained via two-stage propensity score matching; regressions are estimated using matching weights. Variable definitions and controls follow Table 3. Standard errors are clustered by industry and year. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

are not statistically significant across horizons. Importantly, the triple interaction terms Post(τ) × SLL × High Transparency are also not statistically significant in this baseline sample, suggesting that—within the full estimation sample—transparent environmental KPI disclosure is not associated with stronger emission reductions for SLL borrowers.

To further address selection concerns, Table 4 reports estimates from the integrated matched sample obtained via the two-stage propensity score matching procedure. The green-loan coefficients remain negative and become more precisely estimated at longer horizons, with particularly large effects at $t+3$. By contrast, the SLL coefficients remain statistically indistinguishable from zero. The interaction terms with High Transparency are again not statistically significant, indicating limited evidence that KPI transparency strengthens the emissions effect of SLLs within the matched sample.

3.2. Environmental score

We next evaluate whether sustainable loans translate into improvements in external environmental assessments. Table 5 reports DiD estimates where the dependent variable is the Environmental score measured in levels at horizons $t+1$, $t+2$, and $t+3$ after origination. Green loans are associated with a positive and statistically significant increase in the Environmental score at $t+1$, while the coefficients at longer horizons are smaller and not statistically significant. For sustainability-linked loans, the baseline effect is negative at $t+1$ and becomes more negative when KPI transparency is introduced. The interaction terms $Post_{t+1}$ × SLL × High Transparency are positive and statistically significant, indicating that SLLs with transparent environmental KPIs are associated with stronger improvements in environmental scores relative to other SLLs, especially at shorter horizons. At $t+3$, the triple interaction is large and strongly significant, suggesting that KPI transparency is a key dimension driving heterogeneity in SLL effectiveness as measured by external ratings.

Table 6 reports the corresponding estimates in the integrated matched sample. Green loans remain associated with positive improvements in environmental scores across horizons, although statistical significance varies with the specification. For sustainability-linked loans, the estimates again point to meaningful heterogeneity by KPI transparency: the interaction terms with High Transparency are positive and statistically significant, particularly at $t+3$. Overall, these results indicate that while SLLs do not systematically improve environmental scores on average, SLLs with more transparent and measurable environmental KPIs exhibit stronger post-loan improvements in external environmental assessments.

Table 5
DiD estimates for environmental score.

Dependent Variable:	Environmental score	
Model:	(1)	(2)
Variables		
$Post_{t+1}$ × Green	3.27*	3.27*
	(1.86)	(1.86)
$Post_{t+2}$ × Green	1.74	1.73
	(2.47)	(2.47)
$Post_{t+3}$ × Green	0.570	0.553
	(2.83)	(2.83)
$Post_{t+1}$ × SLL	−1.17*	−1.93**
	(0.626)	(0.820)
$Post_{t+2}$ × SLL	0.648	−0.700
	(1.09)	(1.04)
$Post_{t+3}$ × SLL	1.44	−1.30
	(1.47)	(1.59)
$Post_{t+1}$ × SLL × High transparency		1.71**
		(0.866)
$Post_{t+2}$ × SLL × High transparency		2.97
		(2.35)
$Post_{t+3}$ × SLL × High transparency		8.06***
		(2.39)
Other interactions	Yes	Yes
Lead-bank FE	Yes	Yes
Industry FE (1-digit)	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
SE clustered by Industry/Year	Yes	Yes
Observations	5399	5399
R^2	0.12269	0.12307

Clustered standard-errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Notes: The dependent variable is the Environmental Score measured in year $t+\tau$, with Post(τ) indicating $\tau \in \{1,2,3\}$. Variable definitions and controls follow Table 3. Standard errors are clustered by industry and year. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

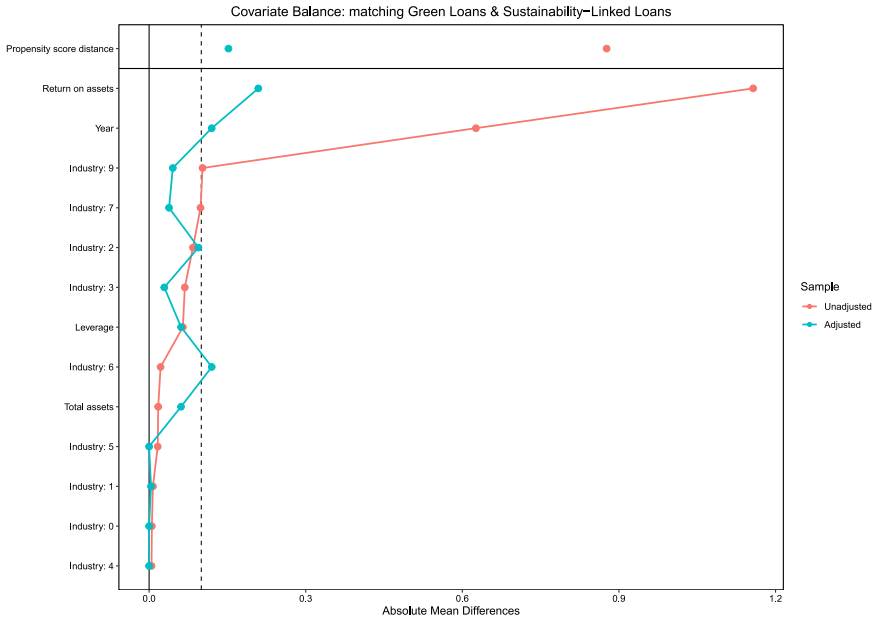
3.3. Matching diagnostics

Fig. 2 summarizes covariate balance before and after matching for the two-stage matching procedure. Standardized mean differences decrease substantially after matching, indicating improved comparability between treated and control groups and supporting the use of the matched sample for the main PSM-DiD analyses.

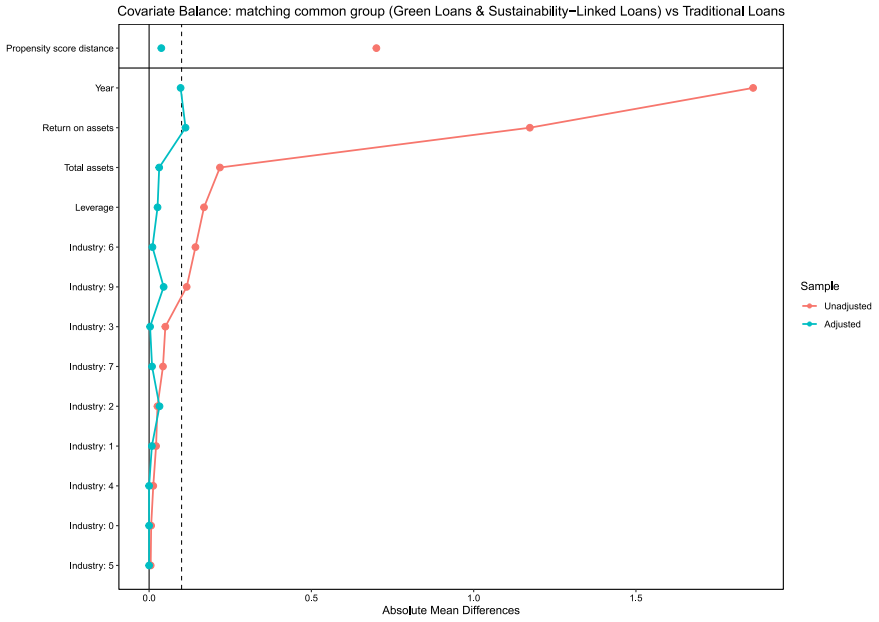
4. Conclusion

This paper examines whether sustainable syndicated loans translate into measurable improvements in firms' environmental performance. Using a comprehensive dataset of syndicated loans issued between 2018 and 2022, we analyze post-origination changes in CO_2 emissions and environmental scores, distinguishing between green loans and sustainability-linked loans (SLLs). By combining difference-in-differences regressions with a propensity score matching framework, we provide evidence on how different contractual structures relate to subsequent environmental outcomes.

Our results point to a clear distinction between green loans and sustainability-linked loans. Green loans are consistently associated with reductions in CO_2 emissions, particularly at medium-term horizons, and with short-term improvements in environmental scores. These findings are consistent with the use-of-proceeds nature of green loans, which directly finance environmentally targeted investments and therefore tend to generate relatively immediate and observable effects. While these effects weaken over longer horizons, they suggest that green loans can play a meaningful role in supporting firms' environmental transitions. In contrast, sustainability-linked loans exhibit more heterogeneous and delayed effects. On average, SLLs are associated with weaker and less robust improvements in environmental outcomes. However, when sustainability-linked loans are characterized by clearly defined and transparent environmental KPIs, their environmental impact becomes more pronounced, especially in terms of environmental ratings. This pattern highlights the importance of contract design and suggests that the effectiveness of SLLs critically depends on the credibility, measurability, and enforceability of their performance targets. Taken together, the findings indicate that not all sustainable lending instruments are equally effective in shaping firms' environmental behavior. While green loans appear to deliver more immediate and observable environmental benefits, the impact of sustainability-linked loans depends crucially on the quality of their contractual features. These results contribute to the growing literature on sustainable finance by moving beyond issuance decisions and pricing effects, and by providing direct evidence on post-loan environmental outcomes. At the same time, several



(a) Matching green loans and SLL.



(b) Matching common group vs. Traditional loans.

Fig. 2. Covariate balance before and after matching.
Notes: This figure shows the results of a two-stage propensity score matching procedure. First, green-loan borrowers are matched to sustainability-linked loan (SLL) borrowers using pre-treatment firm characteristics (return on assets, total assets, leverage, industry, and issuance year). Second, the combined group of green and SLL borrowers is matched to firms issuing conventional loans using the same covariates. Matching is implemented using nearest-neighbor propensity scores without replacement. Covariate balance is assessed through standardized mean differences, which substantially decrease after matching, indicating improved comparability between treated and control firms.

caveats are warranted. First, despite the use of matching techniques and rich controls, loan selection is not random, and unobserved firm characteristics may still influence both loan choice and environmental performance. Second, the availability of detailed information on sustainability-linked loan contracts remains limited, restricting our ability to fully disentangle the role of specific KPI designs. Finally, environmental ratings may not fully capture all dimensions of firms' environmental performance, particularly

Table 6
PSM-DiD estimates for environmental score.

Dependent Variable:	Environmental Score	
Model:	(1)	(2)
Variables		
$Post_{t+1}$ × Green	4.41*	4.56**
	(2.60)	(2.21)
$Post_{t+2}$ × Green	3.76	3.64*
	(2.35)	(2.09)
$Post_{t+3}$ × Green	3.50	3.32
	(2.41)	(2.11)
$Post_{t+1}$ × SLL	−0.236	−2.22
	(1.42)	(1.84)
$Post_{t+2}$ × SLL	6.20**	5.31**
	(2.41)	(2.42)
$Post_{t+3}$ × SLL	4.21	−0.534
	(2.95)	(2.95)
$Post_{t+1}$ × SLL × High transparency		7.53*
		(4.05)
$Post_{t+2}$ × SLL × High transparency		5.75
		(5.89)
$Post_{t+3}$ × SLL × High transparency		12.3***
		(3.38)
Other interactions	Yes	Yes
Lead-bank FE	Yes	Yes
Industry FE (1-digit)	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
SE clustered by Industry/Year	Yes	Yes
Observations	538	538
R^2	0.75257	0.76463

Clustered standard-errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Notes: The sample is the integrated matched sample obtained via two-stage propensity score matching; regressions are estimated using matching weights. Variable definitions and controls follow Table 3. Standard errors are clustered by industry and year. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

when improvements are gradual or difficult to observe. Overall, our findings underscore the importance of contract design and transparency in sustainable finance. As sustainable lending continues to expand, ensuring that environmental objectives are clearly specified, measurable, and verifiable appears crucial for translating financial innovation into tangible environmental progress. Future research could further explore how specific contractual features, monitoring mechanisms, and enforcement provisions shape the real effects of sustainability-linked financial instruments.

CRediT authorship contribution statement

Gennaro de Novellis: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Salvatore Perdichizzi:** Writing – original draft, Supervision, Writing – review & editing. **Gian Paolo Stella:** Writing – original draft, Investigation, Writing – review & editing.

Data availability

The data that has been used is confidential.

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