DOI: https://doi.org/10.17323/j.jcfr.2073-0438.20.1.2026.63-75
JEL classification: G31, G32, Q54, Q56

Firm Financial Exposure to Climate Change Risk and Short-term Debt Maturity

Dinh Phung Tran
Faculty of Finance and Accounting, Saigon University, Ho Chi Minh City, Vietnam,
trandinhphung@sgu.edu.vn, ORCID

Thanh Lam Nguyen ✉
Faculty of Finance and Accounting, Ho Chi Minh City University of Economics and Finance, Ho Chi Minh City, Vietnam,
lamnt2@uef.edu.vn, ORCID

Abstract
This study examines whether firms' financial exposure to climate change risk influences short-term debt maturity and whether biodiversity targets condition this relationship. Using firm-year data for Asian listed firms from 2001 to 2024 obtained from the LSEG Eikon database, we measure short-term debt maturity as the share of total interest-bearing debt maturing within one, two, and three years. We focus on two dimensions of climate exposure–transition and physical climate risk – and investigate how biodiversity targets interact with these risks in shaping maturity choices. Our results show that firms exposed to either transition or physical climate risk rely less on short-term debt, consistent with a refinancing-risk channel in which climate-related uncertainty increases rollover costs and strengthens incentives to extend maturities. Biodiversity targets are additionally associated with lower short-term debt shares, indicating more long-horizon and resilient financing policies among target-setting firms. Importantly, interaction estimates suggest that biodiversity targets attenuate the marginal effect of climate-risk exposure on short-term debt maturity, implying that nature-related commitments may operate as a credibility and risk-buffer mechanism in debt contracting. Overall, the findings highlight debt maturity as a key financial adjustment margin to climate risk and underscore the role of biodiversity-oriented strategies in shaping corporate financial resilience.

Keywords: climate change risk, transition risk, physical risk, debt maturity, short-term debt, biodiversity targets, corporate finance

For citation: Tran D.P., Nguyen T.L. (2026) Firm Financial Exposure to Climate Change Risk and Short-term Debt Maturity. *Journal of Corporate Finance Research.* 20(1): 63-75.https://doi.org/10.17323/j.jcfr.2073-0438.20.1.2026.63-75

Introduction

Climate change has become a first-order driver of firm risk and financing conditions. Firms face both physical risks (e.g., extreme weather, disruptions to production and supply chains) and transition risks (e.g., climate policy tightening, carbon pricing, technological shifts, and changing investor preferences). A rapidly expanding literature shows that climate-related exposures are priced in credit markets and reshape corporate financing outcomes, including capital structure and borrowing costs [1–6]. Yet, an equally important but still underexplored adjustment margin is debt maturity. The maturity structure governs how frequently firms must refinance and therefore determines vulnerability to rollover and liquidity shocks–risks that can be amplified when climate uncertainty increases [7–9].

Traditional theory suggests that in frictionless markets financing choices should not affect firm value [10]. Once market frictions are introduced, however, maturity becomes central to corporate financial policy. Short-term debt can mitigate agency problems by strengthening monitoring and limiting risk-shifting and underinvestment incentives [11–13]. At the same time, heavier reliance on short maturities increases refinancing frequency and exposes firms to rollover risk and inefficient liquidation when credit conditions tighten or lenders update beliefs about firm quality [8; 14; 15]. This fundamental trade-off implies that firms optimally choose maturity in response to shocks that alter expected refinancing costs, information asymmetry, and credit supply [7; 16; 17].

Climate risk is precisely such a shock. First, physical climate exposure raises cash-flow volatility and tail-event risk, increasing the expected cost of rolling over short-term obligations and strengthening incentives to reduce near-term maturity concentration [8; 9]. Second, transition exposure increases policy and regulatory uncertainty, which can cause abrupt repricing and tighter credit, especially for borrowers perceived as carbon-intensive or adjustment-constrained [5; 18–20]. Third, as lenders incorporate climate risk into contracting and pricing, firms may respond by altering maturity to reduce dependence on frequent market access [1; 2; 4; 21]. These mechanisms prompt a core prediction: firms with greater financial exposure to climate change risk should rely less on short-term debt and extend maturity to contain refinancing vulnerability. Recent work begins to document such maturity responses to climate exposure [22–24], but evidence remains limited on when and why the sensitivity of maturity to climate risk varies across firms.

At the same time, nature-related strategy–particularly that associated with biodiversity–has emerged as a new dimension of corporate sustainability and risk governance. Biodiversity targets may serve as a proxy for long-horizon environmental commitments, operational resilience investments, and stronger disclosure and oversight around nature dependencies. Such commitments can affect maturity policy through two competing channels. On the one hand, biodiversity-oriented strategies may encourage conservative liquidity management and maturity matching, reducing short-term debt shares in levels [7; 16]. On the other hand, credible targets may reduce information asymmetry and perceived downside risk, improving credit access and attenuating the maturity extension that climate-exposed firms would otherwise undertake [9]. Consistent with this view, emerging evidence links biodiversity risk to corporate debt maturity choices [25].

Motivated by these considerations, this paper asks: How does firm financial exposure to climate change risk affect short-term debt maturity, and do biodiversity targets condition this relationship? We address this question using firm-year data and three complementary measures of short-term maturity: the shares of debt maturing within one year, within two years, and within three years. This multi-horizon design is important because firms may adjust the short end of the maturity structure non-uniformly, reallocating between maturity buckets rather than shifting a single aggregate measure [16; 17].

Our study makes three contributions. First, we provide evidence that climate risk exposure is associated with materially lower reliance on short-term debt, highlighting maturity structure as a key corporate adaptation margin to climate-related uncertainty. Second, we introduce biodiversity targets as a conditioning strategy variable and show that nature-related commitments not only correlate with maturity in levels but also moderate how strongly climate exposure maps into short-term refinancing dependence. Third, by distinguishing risk types and evaluating multiple short-term cutoffs, we clarify the horizon at which climate risk and biodiversity commitments matter most, helping reconcile heterogeneity documented in recent environmental finance research [4; 22; 23].

The remainder of the paper proceeds as follows. Second section develops hypotheses and reviews related literature. Third section describes the data, variable construction, and empirical design. Fourth section presents the main results and robustness analyses. Fifth section concludes with implications for corporate risk management and debt contracting under climate and nature-related uncertainty.

Theoretical Frameworks and Literature Review

The classical irrelevance proposition of Modigliani and Miller [10] establishes that in frictionless capital markets, firms are indifferent to financing choices, including leverage and debt maturity. In this benchmark setting, refinancing risk, agency conflicts, and information asymmetries are absent, rendering debt maturity irrelevant for firm value. However, extensive theoretical and empirical research demonstrates that once market imperfections are introduced, debt maturity becomes a central element of corporate financial policy [7; 12]. As firms operate in environments characterized by uncertainty, contractual frictions, and institutional constraints, the choice between short-term and long-term debt reflects a complex trade-off between monitoring benefits and refinancing risks.

A core insight from agency theory is that short-term debt can function as a disciplinary mechanism by enhancing creditor monitoring and limiting managerial discretion. Myers [12] argues that short-maturity debt mitigates the debt overhang problem by forcing managers to access capital markets more frequently, thereby reducing incentives for inefficient investment and risk-shifting. This view is reinforced by Barnea et al. [11] and Stulz [13], who emphasize that frequent refinancing strengthens creditor oversight and constrains opportunistic managerial behavior. Empirical evidence further suggests that firms with severe agency problems tend to rely more heavily on short-term debt to substitute for weak governance mechanisms [7].

At the same time, the literature highlights the substantial costs associated with short-term borrowing. Diamond [8] shows that reliance on short-term debt exposes firms to rollover risk and the possibility of inefficient liquidation when creditors reassess firm quality or market conditions deteriorate. Froot et al. [9] demonstrate that refinancing risk can distort firms' investment and financing decisions, leading to underinvestment or precautionary liquidity hoarding. These costs are particularly severe when firms face heightened uncertainty, as even fundamentally sound firms may be denied refinancing during periods of market stress [14]. Consequently, the net benefits of short-term debt depend critically on the stability of the firm's operating and financial environment.

In contrast, long-term debt provides greater financing stability by locking in borrowing conditions and reducing exposure to short-term credit market fluctuations. Prior studies document that firms use longer debt maturities to better match the duration of their assets and investment projects, thereby mitigating refinancing risk [7; 16]. By reducing the frequency of renegotiation with lenders, long-term debt allows firms to sustain investment and operational activities during adverse economic conditions [8]. As a result, firms facing persistent or non-transitory risks may optimally substitute short-term debt for longer maturities.

Risk-based theories further extend this trade-off by emphasizing the role of uncertainty and volatility in shaping debt maturity decisions. A growing body of literature shows that firms actively adjust their maturity structures in response to macroeconomic, political, and policy uncertainty [19; 20]. While short-term debt may preserve flexibility under conditions of moderate uncertainty, excessive volatility amplifies refinancing and liquidity risks, prompting firms to extend debt maturities to avoid repeated exposure to stressed credit markets [14]. These findings underscore that uncertainty fundamentally alters the costs and benefits of short-term borrowing.

More recently, scholars have applied this framework to environmental and climate-related risks, which represent a distinct and increasingly salient source of uncertainty. Climate change exposes firms to physical risks, such as extreme weather events and supply chain disruptions, as well as transition risks arising from regulatory changes, technological shifts, and evolving investor preferences. Nguyen and Phan [5] show that carbon risk reduces corporate leverage, reflecting lenders' heightened risk aversion. Ginglinger and Moreau [2] further demonstrate that climate risk increases borrowing costs and significantly affects firms' capital structure choices. Building on this work, Choi [22] and Goodell et al. [23] provide direct evidence that firms exposed to climate change adjust their debt maturity profiles, highlighting maturity structure as a key margin of financial adjustment to environmental risk.

Environmental risk affects debt maturity through several interrelated channels. First, climate-related shocks increase cash-flow volatility and operational uncertainty, magnifying the refinancing risk associated with short-term debt [8; 9]. Second, environmental risk intensifies regulatory and policy uncertainty, making frequent access to external finance more costly and unpredictable [20]. Third, lenders and investors may reassess firms' long-term viability in response to environmental exposure, further reducing the attractiveness of short-maturity borrowing [2]. In such settings, the traditional monitoring benefits of short-term debt are likely to be dominated by its liquidity and rollover costs.

Institutional theory provides an additional layer of insight by emphasizing the role of legal systems and regulatory environments. Qian and Strahan [26] show that stronger creditor protection and legal enforcement are associated with longer debt maturities, whereas weaker institutional environments encourage reliance on short-term debt. Cross-country evidence confirms that differences in institutional quality explain substantial variation in corporate debt maturity structures [27]. Importantly, environmental regulation has emerged as a key institutional factor shaping corporate financial decisions. Governments worldwide have implemented stricter climate and environmental policies, including disclosure mandates, carbon pricing schemes, and sustainability standards. Compliance with these regulations often requires long-term investments and stable financing arrangements. Consistent with this view, Liang et al. [24] show that firms with stronger climate concerns and greater regulatory exposure tend to issue longer-maturity bonds.

Taken together, the theoretical and empirical literature suggests that environmental and climate-related risks fundamentally reshape the trade-off underlying firms' debt maturity choices. While short-term debt can mitigate agency problems in stable environments, heightened environmental risk amplifies refinancing, liquidity, and regulatory risks, reducing the attractiveness of short-maturity borrowing. As firms increasingly face persistent and non-diversifiable environmental risks, debt maturity emerges as a critical instrument for managing financial stability and sustaining long-term investment.

Integrating insights from agency theory, risk-based theory, and institutional theory, we argue that environmental and climate-related risks fundamentally alter the trade-off between the benefits and costs of short-term debt. While short-term debt can mitigate agency problems under normal conditions, heightened environmental risk increases cash-flow volatility, refinancing uncertainty, and liquidation risk, thereby magnifying the disadvantages of short-maturity borrowing. At the same time, regulatory pressure and institutional constraints associated with environmental risk encourage firms to adopt more stable and long-term financing schemes.

Accordingly, we posit that firms facing higher exposure to environmental and climate-related risks strategically reduce their reliance on short-term debt and extend debt maturity in order to mitigate refinancing and liquidity risks.

Hypothesis 1. *Firms with greater exposure to environmental and climate-related risks rely less on short-term debt.*

Data Sample and Model Specification

Data Sample

We begin by collecting firm-level financial and accounting information for Asian listed firms from the LSEG Eikon database for the 2000-2024 period. Following standard practice in the corporate finance literature, we apply several screening criteria to construct the final sample. First, we exclude financial firms because their balance-sheet structure and regulatory environment imply accounting and financing patterns that are not comparable to those of non-financial firms. Second, we remove firm-year observations with missing or zero values for total assets. Third, we drop firm-year observations with missing values in the dependent variables (short-term debt maturity measures) and the key explanatory variables capturing firms' financial exposure to transition and physical climate risks. In our baseline regressions (Table 2), the final samples comprise 8,389 firm-year observations for the one-year debt maturity ratio, 6,009 observations for the two-year debt maturity ratio, and 4,816 observations for the three-year debt maturity ratio. Descriptive statistics for all variables used in the main analyses are presented in the next section. To mitigate the influence of extreme observations, we winsorize all continuous variables at the 1st and 99th percentiles. To clarify the geographic scope of Asian listed firms, we explicitly identify the countries represented in our data. Based on the baseline specification with the largest sample (Model 1), the dataset covers 1,486 listed firms headquartered in the following 25 Asian countries: Azerbaijan, Bahrain, China, Hong Kong, India, Indonesia, Israel, Japan, South Korea (Republic of Korea), Kuwait, Macau, Malaysia, Mongolia, Oman, Pakistan, the Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, Turkey, the United Arab Emirates, and Vietnam. Because the effective estimation sample varies across specifications due to data availability, the country composition may differ slightly in models with smaller samples.

Variables

Dependent Variables

Our dependent variables measure firms' reliance on short-term debt, capturing their exposure to refinancing and liquidity risk. Following recent literature on corporate debt maturity and financial risk exposure [7; 8; 22], we construct three alternative measures of short-term debt maturity based on the contractual maturity structure of firms' outstanding debt.

Specifically, One-year Debt is defined as the ratio of debt obligations maturing within one year to total interest-bearing debt. Two-year Debt and Three-year Debt are defined analogously as the ratios of debt maturing within two years and three years, respectively, to total debt. These measures are constructed using detailed maturity information from firms' balance sheet disclosures and capture different horizons of refinancing exposure.

Using multiple maturity cutoffs allows us to account for the possibility that firms adjust their debt maturity structure incrementally by shifting debt across adjacent maturity buckets rather than making discrete changes in overall maturity [16; 17]. Moreover, shorter maturity horizons reflect greater sensitivity to rollover risk, as firms with a higher proportion of debt maturing in the near term face the need to refinance more frequently and heightened vulnerability to adverse credit market conditions [8; 9].

Higher values of these short-term debt ratios indicate greater reliance on short-maturity borrowing and, consequently, higher exposure to refinancing and liquidity risk. These measures are widely used in the literature to assess firms' debt maturity structure and provide a suitable framework for examining how external risk exposures, such as climate change risk, affect corporate financing policies.

Explanatory Variables

The key explanatory variables measure firms' financial exposure to climate change risk. We distinguish between two conceptually distinct dimensions of climate risk: physical risk and transition risk. Physical Climate Risk is a binary indicator equal to one if a firm is financially exposed to physical climate-related events, such as extreme weather conditions, natural disasters, or climate-induced disruptions to production and supply chains, and zero otherwise. Transition Climate Risk is a binary indicator equal to one if a firm is exposed to risks arising from the transition toward a low-carbon economy, including changes in environmental regulation, carbon pricing mechanisms, technological shifts, and evolving market or investor preferences.

This distinction follows recent literature emphasizing that physical and transition risks affect firms through different economic channels and may have heterogeneous implications for corporate financial policies [2; 22; 23]. By employing separate indicators for physical and transition climate risk, we are able to disentangle their respective effects on firms' debt maturity choices.

Control Variables

We include a comprehensive set of firm-level control variables that prior studies identify as important determinants of corporate debt maturity. These controls account for differences in firms' investment opportunities, liquidity, profitability, asset structure, and operating characteristics that may independently influence debt maturity decisions [7; 12].

Capital expenditures, scaled by total assets, proxy for firms' investment intensity. Firms with higher investment needs may prefer shorter debt maturities to preserve financial flexibility, or longer maturities to better match the duration of assets and liabilities [16]. Operating cash flow, also scaled by total assets, captures internal liquidity and firms' ability to service debt from operating activities. Firms with stronger cash flows are generally less exposed to refinancing risk and may rely less on short-term debt [8; 15].

Profitability is measured by return on assets, reflecting firms' overall operating performance. More profitable firms typically face lower default risk and better access to long-term financing, which may reduce their reliance on short-maturity debt [28]. Growth opportunities are proxied by Tobin's Q, as firms with higher growth prospects may use shorter debt maturities to mitigate underinvestment and asset substitution problems [12].

We further control for inventory ratio, defined as inventories scaled by total assets, to capture differences in working capital structure and operating cycles that may influence financing needs. Finally, asset tangibility, measured as the ratio of tangible assets to total assets, acts as a proxy for the availability of collateral. Firms with more tangible assets typically have greater access to long-term debt markets and may rely less on short-term borrowing [7; 27].

Model Specification

To examine the relationship between climate risk exposure and debt maturity, we estimate the following baseline regression model:

$$Debt\ Maturity_{i,t} = \alpha + \beta_1 Climate\ Risk_{i,t} + \gamma X_{i,t} + \delta_{industry \times year} + \varepsilon_{i,t}, \quad (1)$$

where $Debt\ Maturity_{i,t}$ denotes one of the short-term debt ratios for firm i in year t, $Climate\ Risk_{i,t}$ represents either physical or transition climate risk exposure, and $X_{i,t}$ is a vector of control variables. All specifications include industry-by-year fixed effects to control for unobserved heterogeneity across industries and time. Standard errors are clustered at the firm and year levels to account for cross-sectional and temporal dependence.

This empirical specification allows us to isolate the association between climate risk exposure and firms' reliance on short-term debt while controlling for firm characteristics and common industry-year shocks.

Empirical Results

Descriptive Statistics

Table 1 reports descriptive statistics for the main variables used in the analysis. On average, firms in the sample hold approximately 20.4% of their total debt maturing within one year, 13.7% within two years, and 12.3% within three years. These figures indicate that a substantial portion of corporate debt is subject to short-term refinancing risk, consistent with prior studies on debt maturity structure [7; 8].

Regarding climate risk exposure, approximately 16.2% of firm-year observations are classified as exposed to physical climate risk, while 16.3% are exposed to transition climate risk. This distribution suggests meaningful cross-sectional variation in firms' climate risk exposure, which is essential for identifying its association with debt maturity choices. The control variables exhibit substantial heterogeneity across firms and align well with summary statistics reported in related literature [27; 28].

Table 1. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	P25	Median	P75	Min	Max
One-year Debt	24.980	0.204	0.217	0.061	0.133	0.258	0.000	0.999
Two-year Debt	16.581	0.137	0.134	0.043	0.103	0.183	0.000	0.719
Three-year Debt	12.147	0.123	0.126	0.039	0.093	0.159	0.000	0.709
Physical Climate Risk	26.421	0.162	0.369	0.000	0.000	0.000	0.000	1.000
Transition Climate Risk	26.421	0.163	0.370	0.000	0.000	0.000	0.000	1.000
Capital Expenditures	80.295	0.056	0.054	0.018	0.040	0.075	0.000	0.279
Operating Cash Flow	80.634	0.075	0.088	0.026	0.069	0.120	-0.196	0.353
Return on Assets	76.823	0.058	0.082	0.019	0.050	0.094	-0.242	0.334
Tobin's Q	70.915	1.615	1.687	0.699	1.027	1.796	0.259	10.617
Inventory Ratio	76.816	0.135	0.127	0.040	0.107	0.186	0.000	0.652
Asset Tangibility	80.419	0.314	0.223	0.132	0.280	0.463	0.000	0.900

Notes: This table reports descriptive statistics for the main variables used in the analysis. Debt maturity ratios measure the proportion of total debt maturing within one, two, and three years, respectively. Climate risk exposure variables are binary indicators capturing firms' exposure to physical and transition climate risks. All continuous variables are winsorized at the 1st and 99th percentiles.

Baseline Regression

Table 2 reports the baseline regression results examining the relationship between firms' exposure to climate change risk and their reliance on short-term debt. Columns (1)–(3) present the results for physical climate risk, while Columns (4)–(6) focus on transition climate risk. Across all specifications, the estimated coefficients on both climate risk measures are negative and statistically significant, indicating that firms exposed to climate-related risks systematically rely less on short-term debt.

The negative association between physical climate risk and short-term debt maturity suggests that firms facing greater exposure to climate-related shocks reduce their reliance on debt that requires frequent refinancing. This finding is consistent with the classic rollover-risk mechanism: when cash flows become more volatile and downside tail events become more likely, short-maturity borrowing becomes costlier because it increases the probability of refinancing under stressed market conditions [8; 9]. Recent evidence further supports the claim that physical climate risk is priced in debt markets and is reflected in credit-relevant terms, including higher borrowing costs and weaker credit risk assessments [3; 6]. Such pricing dynamics strengthen the economic rationale for firms to limit near-term refinancing needs by extending maturity.

Similarly, the results for transition climate risk indicate that firms exposed to regulatory and transition-related uncertainties also hold a lower proportion of short-term debt. Transition risk arising from climate regulation, carbon pricing, and technology shifts can elevate regulatory uncertainty and increase the sensitivity of credit conditions to policy news [19; 20]. Consistent with this channel, recent work using shocks to expected climate regulation shows that climate regulatory risk causally affects bond credit ratings and yield spreads, especially for high-carbon issuers and in stricter regulatory environments [21]. This evidence supports our interpretation that firms respond to transition risk by reducing exposure to frequent refinancing and the associated repricing risk in debt markets.

Importantly, the results are economically meaningful and remain significant across alternative maturity horizons (within one, two, and three years). The stability of the association across cutoffs suggests that firms adjust debt maturity in a broad and persistent manner rather than by merely shifting debt across adjacent maturity buckets [16; 17]. Moreover, the negative relationship for both physical and transition risk is consistent with the view that firms increasingly recognize and measure these risks separately, as emphasized in recent firm-level climate-risk measurement research [4].

Among the controls, asset tangibility is negatively associated with short-term debt in several specifications, consistent with the collateral channel: firms with more pledgeable assets can more easily access longer-term financing [7; 27]. Overall, the baseline evidence supports Hypothesis 1 and highlights debt maturity as a key margin through which firms manage climate-related refinancing and repricing risks.

Table 2. Baseline Regression Results

	(1) One-year Debt	(2) One-year Debt	(3) Two-year Debt	(4) Two-year Debt	(5) Three-year Debt	(6) Three-year Debt
Physical Climate Risk	−0.042*** (−3.87)		−0.012** (−2.08)		−0.023* (−1.82)	
Transition Climate Risk		−0.033*** (−3.26)		−0.013** (−2.52)		−0.024** (−2.46)
Capital Expenditures	0.025 (0.20)	0.026 (0.21)	−0.025 (−0.41)	−0.025 (−0.40)	−0.086 (−1.46)	−0.087 (−1.46)
Operating Cash Flow	0.012 (0.20)	0.009 (0.14)	−0.067 (−1.16)	−0.067 (−1.15)	−0.040 (−0.68)	−0.041 (−0.71)
Return on Assets	−0.020 (−0.23)	−0.022 (−0.25)	0.037 (0.73)	0.036 (0.71)	−0.011 (−0.21)	−0.011 (−0.21)
Tobin's Q	−0.002 (−0.78)	−0.002 (−0.63)	0.005 (1.45)	0.005 (1.45)	0.010*** (4.23)	0.010*** (4.43)
Inventory Ratio	0.000 (0.01)	0.001 (0.02)	0.002 (0.08)	0.002 (0.09)	0.016 (0.41)	0.017 (0.41)

	(1) One-year Debt	(2) One-year Debt	(3) Two-year Debt	(4) Two-year Debt	(5) Three-year Debt	(6) Three-year Debt
Asset Tangibility	−0.100*** (−4.22)	−0.099*** (−4.18)	−0.016 (−1.12)	−0.016 (−1.12)	0.001 (0.05)	0.001 (0.07)
Constant	0.229*** (19.62)	0.227*** (19.84)	0.138*** (19.15)	0.138*** (19.60)	0.119*** (12.99)	0.119*** (13.20)
Industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.026	0.025	0.041	0.041	0.048	0.048
Obs.	8.389	8.389	6.009	6.009	4.816	4.816

Notes: The dependent variables are debt maturity ratios (one-, two-, and three-year debt). All specifications include industry-by-year fixed effects. t-statistics are reported in parentheses. Standard errors are clustered at the firm and year levels. p < 0.10, p < 0.05, *p < 0.01.

Robustness tests

Propensity Score Matching Analysis

Although the baseline regressions control for a rich set of firm characteristics and include industry-by-year fixed effects, firms' exposure to climate change risk may still be non-random. Firms facing physical or transition climate risks can differ systematically from non-exposed firms along dimensions such as investment intensity, profitability, liquidity, growth opportunities, and collateral capacity, which may independently influence debt maturity choices. To further mitigate concerns related to selection on observables, we employ a propensity score matching (PSM) approach that constructs a matched sample of climate-risk-exposed and non-exposed firms with similar observable characteristics [29].

Specifically, we first estimate propensity score models in which the dependent variable is the indicator for physical or transition climate risk exposure, and the explanatory variables consist of the same firm-level controls used in the baseline regressions. The pre-matching estimates reveal that several firm characteristics significantly predict climate risk exposure, confirming that exposed firms are not randomly drawn from the population. We then match climate-risk-exposed firms to non-exposed firms within the same industry-year cells using nearest-neighbor matching with a strict caliper of 0.001. This matching design ensures that treated and control firms face comparable economic and institutional environments, thereby improving the comparability of the two groups.

The post-matching diagnostics indicate that the systematic differences in observable characteristics between climate-risk-exposed and non-exposed firms are substantially reduced. Variables that are significant predictors of climate risk exposure in the pre-match models lose their explanatory power in the post-match stage, suggesting that the matched samples exhibit satisfactory covariate balance. This evidence indicates that the matching procedure effectively aligns treated and control firms along key firm-level dimensions relevant for debt maturity decisions.

Using the matched samples, we re-estimate the outcome regressions for short-term debt maturity. The results show that the negative association between climate risk exposure and short-term debt remains economically and statistically significant after matching. Firms exposed to physical climate risk continue to hold a lower proportion of debt maturing in the near term, consistent with the baseline findings. A similar pattern emerges for transition climate risk, indicating that regulatory and transition-related uncertainties are also associated with a reduced reliance on short-maturity borrowing. Importantly, these effects persist across alternative maturity horizons, suggesting that firms adjust their debt maturity structure in a broad and systematic manner rather than merely shifting debt across adjacent maturity buckets.

The persistence of the climate risk effect in the matched samples strengthens the interpretation that the baseline results are not solely driven by observable firm characteristics. Instead, the PSM evidence supports a refinancing-risk mechanism: when firms face heightened exposure to physical or transition climate risks, the liquidity and rollover costs associated with short-term debt become more salient, incentivizing firms to extend debt maturity in order to secure more stable financing [8; 9]. Overall, the matching results provide additional support for the view that climate change risk represents an economically meaningful determinant of corporate debt maturity choices (Tables 3 and 4).

Table 3. Propensity Score Matching Results for Physical Climate Risk

	(1) Physical Climate Risk Pre-match	(2) Physical Climate Risk Post-match	(3) One-year Debt Matched sample	(4) Two-year Debt Matched sample	(5) Three-year Debt Matched sample
Physical Climate Risk			−0.032** (0.012)	−0.011** (0.004)	−0.020** (0.008)
Capital Expenditures	−2.184*** (0.509)	0.156 (0.692)	−0.151 (0.125)	0.018 (0.103)	−0.028 (0.152)
Operating Cash Flow	1.483*** (0.311)	0.318 (0.428)	0.022 (0.072)	−0.100 (0.091)	−0.170** (0.068)
Return on Assets	−1.379*** (0.330)	−0.459 (0.470)	−0.197 (0.119)	0.037 (0.056)	0.150*** (0.046)
Tobin's Q	−0.119*** (0.013)	0.008 (0.017)	0.005 (0.004)	0.006 (0.005)	0.011* (0.006)
Inventory Ratio	0.017 (0.153)	0.114 (0.196)	−0.014 (0.047)	0.020 (0.023)	−0.002 (0.059)
Asset Tangibility	−0.041 (0.099)	-0.034 (0.132)	−0.096*** (0.024)	−0.015 (0.015)	0.022 (0.015)
Constant	−1.370*** (0.046)	−0.024 (0.060)	0.238*** (0.013)	0.135*** (0.012)	0.118*** (0.013)
Obs.	24.600	8.090	2.916	2.177	1.713
Pseudo R^2 / Adj. R^2	0.009	0.000	0.016	0.033	0.043

Notes: Columns (1)–(2) report propensity score (PS) models estimated before and after matching, respectively. Columns (3)–(5) report outcome regressions estimated on the matched sample for one-, two-, and three-year debt maturity ratios. Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Propensity Score Matching Results for Transition Climate Risk

	(1) Transition Climate Risk Pre-match	(2) Transition Climate Risk Post-match	(3) One-year Debt Matched sample	(4) Two-year Debt Matched sample	(5) Three-year Debt Matched sample
Transition Climate Risk			−0.027 (0.016)	−0.016*** (0.005)	−0.026* (0.013)
Capital Expenditures	−1.963*** (0.505)	0.799 (0.689)	−0.112 (0.110)	0.008 (0.085)	−0.204* (0.113)
Operating Cash Flow	1.526*** (0.310)	0.480 (0.428)	0.020 (0.089)	−0.082 (0.076)	−0.030 (0.143)
Return on Assets	−1.196*** (0.331)	−0.504 (0.475)	−0.023 (0.152)	0.089 (0.053)	0.068 (0.121)
Tobin's Q	−0.132*** (0.013)	−0.001 (0.017)	−0.002 (0.004)	0.000 (0.002)	0.004 (0.006)
Inventory Ratio	−0.022 (0.153)	0.050 (0.195)	0.016 (0.043)	0.017 (0.026)	0.034 (0.053)

	(1) Transition Climate Risk Pre-match	(2) Transition Climate Risk Post-match	(3) One-year Debt Matched sample	(4) Two-year Debt Matched sample	(5) Three-year Debt Matched sample
Asset Tangibility	−0.038 (0.099)	0.043 (0.130)	−0.086*** (0.020)	−0.013 (0.012)	0.017 (0.023)
Constant	−1.362*** (0.046)	−0.065 (0.059)	0.224*** (0.012)	0.140*** (0.009)	0.126*** (0.016)
Obs.	24.569	8.134	2.916	2.175	1.737
Pseudo R^2 / Adj. R^2	0.009	0.000	0.025	0.030	0.028

Notes: Columns (1)–(2) report propensity score (PS) models estimated before and after matching, respectively. Columns (3)–(5) report outcome regressions estimated on the matched sample for one-, two-, and three-year debt maturity ratios. Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Placebo Tests

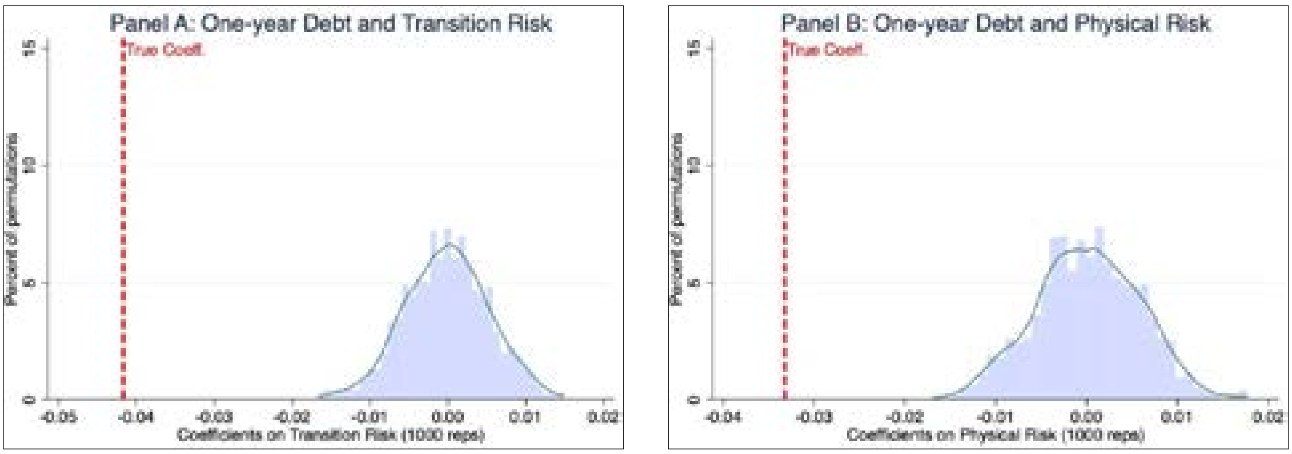
This section examines whether the estimated effects of climate change risk on short-term debt maturity could be driven by random assignment of climate risk exposure. To this end, we randomly assign the values of one or zero to firms as placebo indicators for transition risk and physical risk, drawn from a uniform distribution. We then re-estimate Equation (1) using these placebo variables and repeat the procedure 1,000 times for each debt maturity horizon.

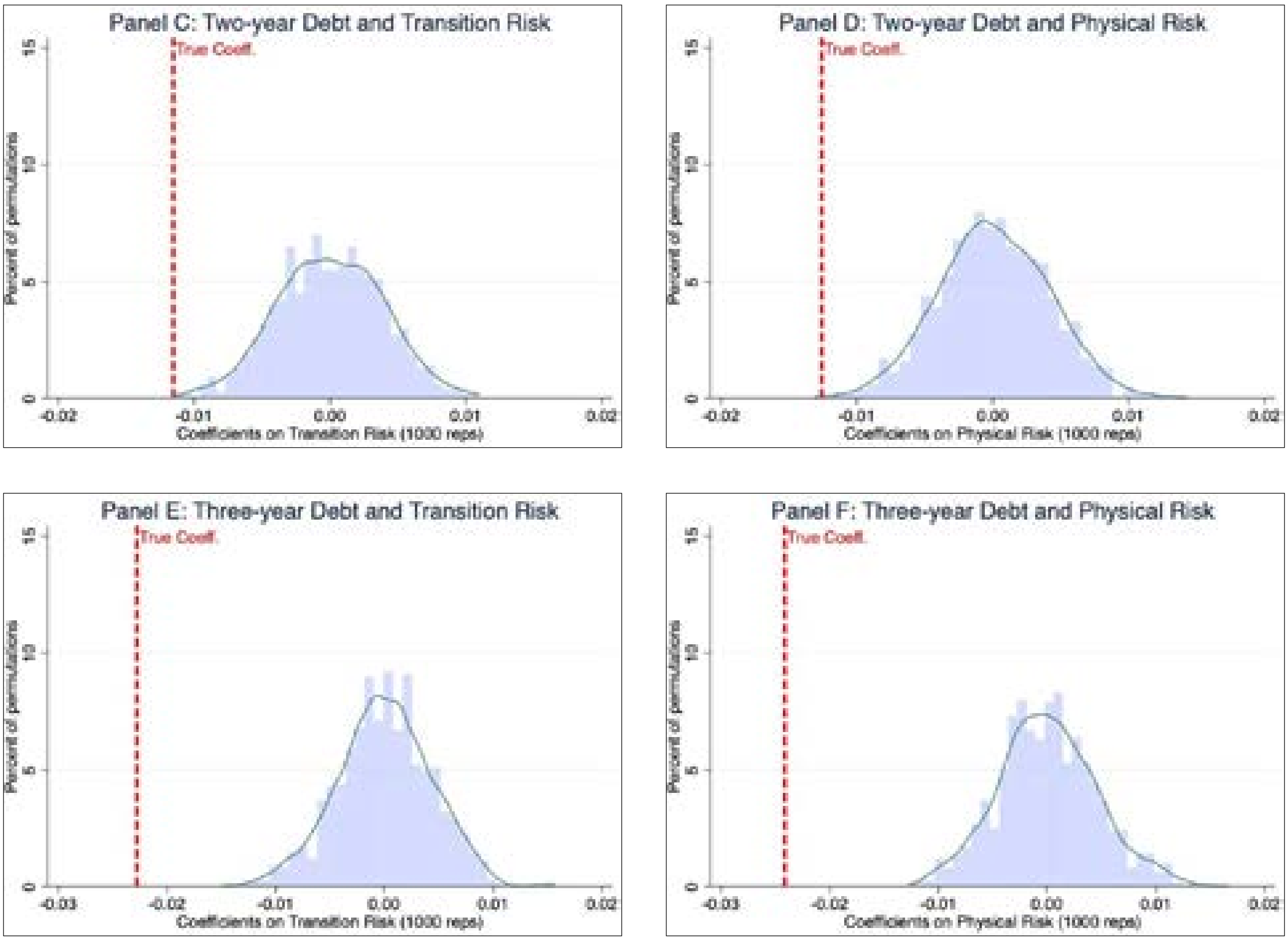
Figure 1 reports the distributions of the coefficient estimates obtained from the randomized placebo tests. Panels A, C, and E correspond to transition risk for debt maturing within one year, two years, and three years, respectively. Panels B, D, and F report the corresponding results for physical risk. In all panels, the distributions of placebo coefficients are centered around zero, indicating that randomly assigned climate risk does not systematically explain firms' short-term debt maturity.

The vertical dashed red lines represent the coefficient estimates obtained using the actual climate risk measures. Across all panels, the true estimates are located far to the left of the placebo distributions and lie outside the range where the majority of randomized estimates are concentrated. This pattern is observed consistently across both transition and physical risk measures and across all debt maturity horizons.

Overall, the randomization results suggest that the baseline findings are unlikely to be driven by random variation in climate risk assignment. Instead, the relationship between climate change risk exposure and short-term debt maturity reflects a systematic pattern in the data rather than a mechanical outcome of random measurement.

Figure 1. Estimates using Randomized Physical Risk and Transition Risk





Mechanism: The moderating role of biodiversity targets

Table 5 examines whether firms' financial exposure to climate change risk is associated with the maturity profile of short-term debt, and whether this association is moderated by firms' biodiversity targets. Across specifications, both transition and physical climate-risk exposure are negatively associated with short-term debt shares. The estimated coefficients are economically meaningful: for instance, higher transition (physical) exposure is linked with a lower one-year debt share, and the negative sign persists for the two-year and three-year maturity buckets. This pattern is consistent with a refinancing-risk channel: when climate risk raises uncertainty about future cash flows and collateral values, firms have incentives to reduce rollover vulnerability by decreasing reliance on short-maturity debt [8; 9]. In this view, climate risk functions as an external shock that amplifies liquidity risk and the probability of inefficient liquidation under short-term financing [8].

Importantly, our baseline results complement recent evidence that environmental risks reshape debt structure. For example, Goodell et al. [23] document that firm-level climate risk affects corporate debt maturity choices, while Ginglinger and Moreau [2] show that climate risk materially affects corporate financing decisions. Compared with settings where climate exposure may increase short-term borrowing for flexibility [22], our findings suggest that, when climate risk is financially salient, firms appear to term out debt to contain rollover exposure.

The coefficient on biodiversity targets is negative and statistically significant across all maturity buckets, suggesting that firms committing to biodiversity targets hold less short-term debt. One interpretation is that biodiversity-target setters follow a longer-horizon financial policy, aligning financing maturity with longer payback periods of environmental investments, and/or adopting more conservative liquidity management to stabilize stakeholder commitments. This is consistent with an emerging strand of literature emphasizing that nature- and biodiversity-related risks and commitments can influence corporate financial policies [25].

A key contribution of Table 5 is the interaction between climate-risk exposure and biodiversity targets. The interaction terms are positive and highly significant for the one-year debt share, and positive (though weaker) for the three-year bucket. This indicates that biodiversity targets attenuate the negative association between climate-risk exposure and short-term debt reliance. Put differently, for climate-exposed firms, setting biodiversity targets is associated with a smaller reduction in short-term debt shares.

This moderation effect is consistent with a credibility and risk-management mechanism. Biodiversity targets may serve as a verifiable signal of stronger environmental governance, improved disclosure quality, and more proactive risk mitigation, which can reduce lenders' concerns about downside tail risks and information asymmetry. As a result, creditors may be more willing to provide (or roll over) short-term funding even when climate exposure is high. Such an interpretation aligns with the broader corporate finance view that credible risk management reduces financing frictions and improves access to external capital [9]. It is also consistent with the evidence that environmental risks are priced differently across maturity segments in debt markets [21].

Table 5. Moderating Role of Biodiversity Targets

	(1) One-year Debt	(2) One-year Debt	(3) Two-year Debt	(4) Two-year Debt	(5) Three-year Debt	(6) Three-year Debt
Transition climate risk	−0.045** (−3.64)		−0.013* (−2.02)		−0.027 (−1.78)	
Physical climate risk		−0.036** (−3.12)		−0.014* (−2.23)		−0.028* (−2.36)
Biodiversity targets	−0.079*** (−6.07)	−0.076*** (−6.26)	−0.042*** (−3.86)	−0.037** (−3.10)	−0.042** (−3.59)	−0.045*** (−4.27)
Transition climate risk × Biodiversity targets	0.063*** (4.54)		0.014 (1.80)		0.034* (1.97)	
Physical climate risk × Biodiversity targets		0.058*** (4.48)		0.007 (0.73)		0.040* (2.39)
Capital Expenditures	0.038 (0.24)	0.040 (0.25)	0.029 (0.37)	0.030 (0.39)	−0.137 (−1.73)	−0.141 (−1.78)
Operating Cash Flow	0.033 (0.44)	0.027 (0.35)	−0.048 (−0.43)	−0.048 (−0.43)	0.027 (0.35)	0.024 (0.33)
Return on Assets	−0.102 (−1.03)	−0.104 (−1.05)	−0.023 (−0.59)	−0.026 (−0.65)	0.025 (0.37)	0.025 (0.37)
Tobin's Q	−0.005* (−2.03)	−0.005 (−1.80)	0.002 (0.66)	0.002 (0.66)	0.006* (2.23)	0.007* (2.44)
Inventory Ratio	−0.038 (−0.93)	−0.037 (−0.91)	0.028 (0.92)	0.028 (0.93)	0.056 (0.98)	0.056 (0.96)
Asset Tangibility	−0.117*** (−4.86)	−0.115*** (−4.77)	−0.032 (−1.58)	−0.032 (−1.60)	0.011 (0.55)	0.012 (0.56)
Constant	0.256*** (18.05)	0.250*** (18.62)	0.147*** (13.16)	0.148*** (14.05)	0.126*** (8.12)	0.126*** (9.02)
Industry × Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.025	0.021	0.012	0.012	0.024	0.025
Observations	3.685	3.685	2.468	2.468	1.981	1.981

Notes: This table examines the moderating role of biodiversity targets in the relation between firms' climate-risk exposure and short-term debt maturity. The dependent variables are the ratios of total interest-bearing debt maturing within one year (One-year Debt), within two years (Two-year Debt), and within three years (Three-year Debt). Transition climate risk and physical climate risk are indicator variables capturing firms' exposure to transition and physical climate risks, respectively. Biodiversity targets is an indicator equal to one if the firm commits to biodiversity targets and zero otherwise. Columns (1), (3), and (5) present specifications for transition climate risk and its interaction with biodiversity targets, while Columns (2), (4), and (6) present specifications for physical climate risk and its interaction with biodiversity targets. All regressions control for Capital Expenditures, Operating Cash Flow, Return on Assets, Tobin's Q, Inventory ratio, and Asset Tangibility. Industry × year fixed effects are included. t-statistics are reported in parentheses. Standard errors are two-way clustered at the firm and year levels. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Conclusion

This paper examines how firms' financial exposure to climate change risk shapes the maturity profile of corporate debt, with a focus on short-term refinancing dependence. Building on the canonical trade-off between monitoring benefits of short-term debt and its rollover costs [7; 8; 11; 12], we argue that climate risk increases refinancing frictions and tail-risk concerns, thereby strengthening firms' incentives to reduce short-term maturity concentration. We further investigate whether biodiversity targets – an increasingly salient dimension of nature-related strategy–directly relate to maturity choices and condition the maturity response to climate exposure.

Across baseline specifications and robustness designs, we document three main findings. First, higher climate-risk exposure (both physical and transition dimensions) is associated with a significantly lower share of short-term debt, consistent with firms actively managing rollover vulnerability when climate uncertainty intensifies [8; 9; 22; 23]. Second, biodiversity targets are strongly and negatively related to short-term debt shares, suggesting that target-setting firms adopt more long-horizon and resilient financing policies, consistent with maturity-matching considerations in debt design [7; 16; 17]. Third, the interaction evidence indicates that biodiversity targets mitigate the marginal sensitivity of short-term debt to climate risk exposure, implying that nature-related commitments may operate as a credibility and risk-buffer channel that relaxes refinancing pressure for climate-exposed firms [9; 25].

These results carry several implications. For corporate managers, the evidence highlights debt maturity as an important adaptation margin to climate-related uncertainty: reducing near-term refinancing reliance can lower liquidity fragility when climate risks trigger sudden repricing or credit tightening [14; 15]. For lenders and investors, our findings suggest that climate exposure and nature-related strategy jointly shape the risk profile of corporate debt. Transition and physical climate risks can translate into maturity restructuring, while biodiversity targets appear to contain the maturity adjustment required under high climate exposure, potentially reflecting stronger governance, disclosure, and adaptive capacity. This is consistent with evidence that climate risks are priced in debt markets and incorporated into credit contracting [1–3; 21]. For policymakers, the results underscore that corporate commitments, such as biodiversity targets, may interact with climate-risk exposure in shaping financial resilience, indicating a potential role for disclosure standards and incentive schemes that improve the credibility and comparability of nature-related commitments.

Our study is subject to several limitations that motivate future research. First, while we employ rich controls and identification strategies, causal interpretation may still be challenged by unobserved firm traits that jointly drive sustainability commitments and financing policies. Future work could extend quasi-experimental designs–e.g., exploiting regulatory shocks or disclosure mandates–and implement matching frameworks to sharpen causal inference [29]. Second, measurement of climate exposure and biodiversity targets can be refined as data availability improves; subsequent studies may examine whether alternative risk metrics, or more granular nature-related disclosures, yield differential maturity responses [4]. Third, an important extension is to investigate the pricing dimension jointly with maturity choice–how climate and nature-related factors influence not only maturity structure but also spreads, covenants, and loan/bond contract features [1; 3; 24]. Finally, future research may explore cross-country heterogeneity in institutions and creditor rights, which can condition the maturity channel through contractual enforcement and bank-loan design [26; 27].

Overall, our findings suggest that climate-risk exposure and biodiversity targets jointly shape corporate maturity policy in a non-additive manner. Debt maturity thus represents a key component of financial resilience in the transition to a low-carbon economy and in the broader shift toward managing nature-related risks.

References

1. Ehlers T., Packer F., De Greiff K. The pricing of carbon risk in syndicated loans: Which risks are priced and why? *Journal of Banking & Finance*. 2022;136:106180. https://doi.org/10.1016/j.jbankfin.2021.106180

2. Ginglinger E., Moreau Q. Climate risk and capital structure. *Management Science*. 2023;69(12):7151-7882. https://doi.org/10.1287/mnsc.2023.4952

3. Kempa K. Physical climate risk and the pricing of bank loans. *Journal of Environmental Economics and Management*. 2025;137;103280. https://doi.org/10.1016/j.jeem.2025.103280

4. Li Q., Shan H., Tang Y., et al. Corporate climate risk: Measurements and responses. *The Review of Financial Studies*. 2024;37(6):1778-1830. https://doi.org/10.1093/rfs/hhad094

5. Nguyen J.H., Phan H.V. Carbon risk and corporate capital structure. *Journal of Corporate Finance*. 2020;64:101713. https://doi.org/10.1016/j.jcorpfin.2020.101713

6. Trinh V.Q., Trinh H.H., Li T., et al. Climate change exposure, financial development, and the cost of debt: Evidence from EU countries. *Journal of Financial Stability*. 2024;74:101315. https://doi.org/10.1016/j.jfs.2024.101315

7. Barclay M.J., Smith C.W. Jr. The maturity structure of corporate debt. *The Journal of Finance*. 1995;50(2):609-631. https://doi.org/10.1111/j.1540-6261.1995.tb04797.x

8. Diamond D.W. Debt maturity structure and liquidity risk. *The Quarterly Journal of Economics*. 1991;106(3):709-737. https://doi.org/10.2307/2937924

9. Froot K.A., Scharfstein D.S., Stein J.C. Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance*. 1993;48(5):1629-1658. https://doi.org/10.1111/j.1540-6261.1993.tb05123.x
10. Modigliani F., Miller M.H. The cost of capital, corporation finance and the theory of investment. *The American Economic Review*. 1958;48(3):261-297. Accessed on 17.10.2025. URL: https://www.jstor.org/stable/1809766
11. Barnea A., Haugen R.A., Senbet L.W. A rationale for debt maturity structure and call provisions in the agency theoretic framework. *The Journal of Finance*. 1980;35(5):1223-1234. https://doi.org/10.1111/j.1540-6261.1980.tb02205.x
12. Myers S.C. Determinants of corporate borrowing. *Journal of Financial Economics*. 1977;5(2):147-175. https://doi.org/10.1016/0304-405X(77)90015-0
13. Stulz R. Managerial discretion and optimal financing policies. *Journal of Financial Economics*. 1990;26(1):3-27. https://doi.org/10.1016/0304-405X(90)90011-N
14. González V.M. The financial crisis and corporate debt maturity: The role of banking structure. *Journal of Corporate Finance*. 2015;35:310-328. https://doi.org/10.1016/j.jcorpfin.2015.10.002
15. Harford J., Klasa S., Maxwell W.F. Refinancing risk and cash holdings. *The Journal of Finance*. 2014;69(3):975-1012. https://doi.org/10.1111/jofi.12133
16. Barclay M.J., Marx L.M., Smith C.W. Jr. The joint determination of leverage and maturity. *Journal of Corporate Finance*. 2003;9(2):149-167. https://doi.org/10.1016/S0929-1199(02)00003-2
17. Gopalan R., Song F., Yerramilli V. Debt maturity structure and credit quality. *Journal of Financial and Quantitative Analysis*. 2014;49(4):817-842. https://doi.org/10.1017/S0022109014000520
18. Baker S.R., Bloom N., Davis S.J. Measuring economic policy uncertainty. *The Quarterly Journal of Economics*. 2016;131(4):1593-1636. https://doi.org/10.1093/qje/qjw024
19. Datta S., Doan T., Iskandar-Datta M. Policy uncertainty and the maturity structure of corporate debt. *Journal of Financial Stability*. 2019;44:100694. https://doi.org/10.1016/j.jfs.2019.100694
20. Jens C.E. Political uncertainty and investment: Causal evidence from US gubernatorial elections. *Journal of Financial Economics*. 2017;124(3):563-579. https://doi.org/10.1016/j.jfineco.2016.01.034
21. Benkraiem R., Dimic N., Piljak V., et al. Media-based climate risks and international corporate bond market. *Journal of International Money and Finance*. 2025;151:103260. https://doi.org/10.1016/j.jimonfin.2024.103260
22. Choi S. Climate change exposure and the use of short-term debt. *Finance Research Letters*. 2024;65:105579. https://doi.org/10.1016/j.frl.2024.105579
23. Goodell J.W., Palma A., Paltrinieri A., et al. Firm-level climate change risk and corporate debt maturity. *Journal of International Money and Finance*. 2025;152:103275. https://doi.org/10.1016/j.jimonfin.2025.103275
24. Liang C., Yang J,. Shen L., et al. Bonds for a bluer tomorrow: Corporate climate concern and its impact on corporate bond maturities. *Journal of International Money and Finance*. 2025;153:103296. https://doi.org/10.1016/j.jimonfin.2025.103296
25. Duong K.T., Nguyen T.T., Tram H.T.X. Biodiversity risk and corporate debt maturity. *International Review of Financial Analysis*. 2025;107:104556. https://doi.org/10.1016/j.irfa.2025.104556
26. Qian J., Strahan P.E. How laws and institutions shape financial contracts: The case of bank loans. *The Journal of Finance*. 2007;62(6):2803-2834. https://doi.org/10.1111/j.1540-6261.2007.01293.x
27. Fan J.P., Titman S., Twite G. An international comparison of capital structure and debt maturity choices. *Journal of Financial and Quantitative Analysis*. 2012;47(1):23-56. https://doi.org/10.1017/S0022109011000597
28. Datta S., Iskandar-Datta M., Raman K. Managerial stock ownership and the maturity structure of corporate debt. *The Journal of Finance*. 2005;60(5):2333-2350. https://doi.org/10.1111/j.1540-6261.2005.00800.x
29. Rosenbaum P.R., Rubin D.B. The central role of the propensity score in observational studies for causal effects. *Biometrika*. 1983;70(1):41-55. https://doi.org/10.1093/biomet/70.1.41

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted on** 19.01.2026; **approved after reviewing on** 02.02.2026; **accepted for publication on** 15.02.2026