Climate Risk Disclosure and the Cost of Capital: Unpacking the Roles of Disclosure Quality, Risk Vectors, and Institutional Governance

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ABSTRACT

This study investigates the financial transmission channels through which corporate climate risk disclosure quality, bifurcated risk vectors and country-level institutional governance shape the corporate cost of capital. Analysing an unbalanced global panel of 2,140 listed firms across 12 jurisdictions over 2018–2025 (N = 14,250 firm-year observations), we deploy a fine-tuned Climate-BERT Natural Language Processing (NLP) pipeline to separate substantive carbon accounting from symbolic boilerplate narratives. Our two-way fixed-effects (TWFE) and two-stage least squares (2SLS) estimates reveal that disclosure volume alone does not lower financing costs; rather, capital market rewards depend strictly on reporting depth and institutional credibility. A one-standard-deviation increase in substantive, auditable climate disclosure reduces the implied cost of equity (COE) by 321 basis points and the cost of debt (COD) by 182 basis points by mitigating information asymmetry. Conversely, capital markets penalize narrative boilerplate text as a proxy for green washing risk, inflating COE by 135 basis points and COD by 81 basis points. Furthermore, we document severe pricing divergence across climate risk vectors: a one-standard-deviation increase in transition risk disclosures reduces COE by 423 basis points and COD by 367 basis points, whereas physical risk disclosures yield comparatively muted reductions (88 and 68 basis points, respectively). Finally, moderation analysis demonstrates that the financing benefits of climate transparency are strictly contingent upon baseline country-level regulatory enforcement; in weak governance regimes, corporate climate claims lack credible legal backing, neutralizing their capacity to alleviate financial constraints. These findings offer immediate policy insights for standard-setters and executives implementing the International Sustainability Standards Board's (ISSB) IFRS S2 framework.

KEYWORDS

Climate Risk Disclosure, Cost of Equity, Cost of Debt, Transition Risk, Green washing, IFRS S2, Institutional Governance

I. INTRODUCTION

A. Background of the Study

In the contemporary global economy, climate change has evolved from a peripheral corporate social responsibility (CSR) issue into a fundamental driver of systemic financial

risk. As international standard-setters accelerate the transition toward mandatory reporting, the International Sustainability Standards Board's (ISSB) IFRS S2 platform has shifted from a theoretical blueprint into an operational regulatory benchmark. As of 2025 and 2026, the standard has reached phased enforcement across more than 35 global jurisdictions representing roughly 60% of global GDP. This includes active or mandatory reporting timelines across key financial hubs such as Australia, Singapore, Hong Kong, and pioneer emerging markets like Nigeria and Brazil, while other economic centres like the United Kingdom and Japan have finalized local frameworks designed to achieve functional alignment. Consequently, understanding how the quality and depth of climate risk disclosure intersects with a firm's cost of capital has emerged as a cornerstone of modern sustainable finance and accounting literature.

Theoretically, the financial implications of corporate climate disclosures operate primarily through information economics channels. According to information asymmetry theory, comprehensive and transparent climate risk communication bridges the data gap between corporate managers and external financiers, reducing investor uncertainty and lowering the cost of equity via reduced risk premiums. Furthermore, from a stakeholder agency perspective, firms that voluntarily or mandatorily provide robust climate-risk disclosures signal superior long-term risk management capabilities. This signalling effect mitigates the perceived probability of future environmental distress, litigation, or stranded assets, which directly lowers the cost of debt financing from commercial banks and bond markets. However, despite these theoretical foundations, empirical findings remain highly fragmented, demonstrating that the capital market rewards of climate disclosure are conditional upon reporting credibility, risk categorization, and localized governance frameworks.

B. Statement of the Research Problem

Despite growing documentation on the broad capital market benefits of corporate sustainability reporting, substantial friction persists in how global financial markets process, verify, and price qualitative climate disclosures. Specifically, three critical problems remain unresolved in contemporary accounting and finance research.

First, while genuine climate risk disclosure reduces capital costs, firms frequently resort to selective, superficial environmental disclosures commonly termed green washing to manipulate market perceptions. When capital markets detect these superficial disclosures, they impose structural penalties by inflating the cost of capital, making corporate debt and equity more expensive. However, contemporary empirical methodologies struggle to distinguish between substantive, high-quality carbon accounting and narrative fluff, creating an asymmetric information environment where debt holders routinely penalize heavily exposed firms regardless of their reporting volume.

Second, prior archival research often treats corporate climate risk as a monolithic variable, overlooking how differently debt and equity investors respond to distinct climate risk vectors. Recent empirical data suggests that transition risk disclosures (e.g., low-carbon technology compliance costs) exert a significantly stronger cost-reducing effect on corporate financing than physical risk disclosures. This divergence leaves a substantial gap in the literature regarding which specific climate vectors require prioritized capital allocation and

how different capital suppliers (banks versus public equity investors) weigh these risks under varying market conditions.

Third, the transmission channels through which climate disclosure alleviates a firm's financial constraints are highly sensitive to regional regulations and baseline institutional quality. In emerging economies, the positive impact of climate disclosure on reducing the cost of capital is strictly dependent on the baseline quality of country-level governance and regulatory enforcement. Without effective legal frameworks, the credibility of corporate climate statements is compromised, meaning that the capacity of climate risk disclosure to alleviate capital constraints remains highly constrained in developing financial ecosystems compared to developed Western markets.

C. Research Hypotheses

To rigorously examine these financial channels, the following non-directional hypotheses are tested:

- H1: There is a statistically significant relationship between the nature of corporate carbon disclosures (substantive, verifiable carbon accounting vs. descriptive, boilerplate narrative) and a firm’s cost of capital.
- H2: There is a statistically significant difference between the cost-reducing effects of corporate transition climate risk disclosures and physical climate risk disclosures on a firm's equity and debt financing.
- H3: The relationship between high-quality climate risk disclosure and a firm’s cost of capital is significantly moderated by the level of regional regulatory enforcement and institutional governance quality.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

A. Conceptual Review

To evaluate how corporate climate risk transparency intersects with financial market dynamics, it is necessary to establish the theoretical boundaries of corporate sustainability reporting, asset pricing, and institutional governance. Corporate climate disclosure functions as a multi-channelled financial signal structured by the precision of carbon accounting, the specific nature of the environmental threat, and the regulatory environment in which the firm operates.

1. Substantive versus Symbolic Climate Risk Disclosure

Corporate environmental transparency is fundamentally divided between substantive reporting and symbolic disclosure quality. Substantive climate disclosure involves verifiable carbon accounting, independent third-party audits, granular metrics (including Scopes 1, 2, and 3 emissions), and explicit financial capital expenditures allocated to environmental mitigation. This rigorous approach directly reduces information asymmetry by providing hard, audit-ready data that debt and equity markets can reliably price. Conversely, symbolic disclosure relies on descriptive, boilerplate narratives and selective optimism designed to manipulate stakeholder perceptions without altering operational risk profiles—a practice commonly termed

green washing. When capital markets detect these superficial, decoupled disclosures, they impose structural penalties by inflating the cost of capital.

2. *Bifurcated Climate Risk Vectors: Physical versus Transition Risks*

Financial markets differentiate between two primary risk vectors that carry distinct asset-pricing implications. Physical climate risks represent direct, tangible threats to a firm's operational infrastructure, comprising acute events (e.g., extreme weather asset damages) and chronic environmental shifts. Debt and equity providers view physical risks as highly localized disruptions that endanger long-term asset values and corporate liquidity. On the other hand, transition climate risks encompass the structural, regulatory, and technological adjustments required to align with a low-carbon economy, such as carbon taxes, compliance penalties, and stranded asset write-downs. Recent empirical data suggests that transition risk disclosures exert a significantly stronger cost-reducing effect on corporate financing than physical risk disclosures.

3. *Information Economics, Signalling, and the Cost of Capital*

According to information asymmetry theory, comprehensive and transparent climate risk communication bridges the data gap between corporate managers and external financiers. By reducing investor uncertainty regarding hidden environmental liabilities, it lowers the cost of equity via reduced risk premiums. Furthermore, from a stakeholder agency perspective, firms that provide robust climate disclosures signal superior long-term risk management capabilities. This signalling effect mitigates the perceived probability of future environmental distress, litigation, or stranded assets, which directly lowers the cost of debt financing from commercial banks and bond markets.

4. *The Moderating Role of Institutional Quality and Regulatory Enforcement*

The transmission channels through which climate disclosure alleviates a firm's financial constraints are highly sensitive to regional regulations and baseline institutional quality. In strong regulatory environments with stringent legal enforcement and standardized reporting mandates, such as the ISSB's IFRS S2 framework, corporate statements are legally bound, which enhances disclosure credibility. However, in emerging economies or weak legal ecosystems, the positive impact of climate disclosure on reducing the cost of capital is strictly dependent on the baseline quality of country-level governance.

B. Theoretical Framework

1. *Information Asymmetry Theory and the Cost of Equity*

Information asymmetry theory posits that corporate managers naturally possess private, localized insights regarding structural risk profiles that are externalized or hidden from outside financiers. In the contemporary sustainable finance domain,

climate hazards represent a massive source of unpriced or hidden liabilities. When a firm selectively suppresses or provides low-quality, boilerplate environmental disclosures, capital markets face adverse selection frictions, prompting public equity investors to demand an inflated equity risk premium to insulate against uncertainty. Conversely, providing substantive, auditable carbon accounting serves as an effective mechanism to bridge the data gap.

2. *Signalling Theory and Risk Vector Pricing Frictions*

Signalling theory clarifies how corporate agents utilize deliberate, high-cost actions to communicate unobservable firm characteristics—such as strategic agility and climate preparedness—to sceptical external stakeholders. Because true environmental transition strategies require intense capital expenditure allocations, substantive climate reporting represents a high-integrity, un-fakable signal. However, signalling efficiencies break down when firms emit superficial narratives or green washing fluff to artificially optimize market reputation. Furthermore, capital suppliers differentiate heavily across distinct climate risk vectors because they signify varying horizons of strategic disruption. Transition risk disclosures convey immediate managerial capacity to absorb policy shocks, whereas physical risk exposures represent highly localized asset volatility.

3. *Agency Theory and the Moderating Mechanism of Institutional Governance*

From a stakeholder agency perspective, corporate managers may have strong incentives to strategically hide climate risks to protect short-term bonus metrics or mask structural asset sub-optimization. This opportunistic behaviour elevates agency costs for both debt holders and equity holders, who fear eventual litigation, regulatory penalties, or stranded asset write-downs. While robust climate reporting acts as a governance monitoring mechanism that aligns managerial incentives with long-term shareholder value, the operational strength of this mechanism is deeply contextual. Institutional quality acts as a critical moderating boundary; in nations characterized by strict legal enforcement and structured transparency regimes like the IFRS S2 platform, corporate agency costs are minimized because regulatory frameworks penalize false signals.

C. Empirical Literature Review

Recent literature focuses on breaking down environmental parameters into specific climate risk vectors. Caragnano et al. (2020) analysed the energy sector, demonstrating that carbon disclosures only mitigate corporate risk when the reporting context is reliable and embedded in proactive corporate strategy. Bakar et al. (2024) confirmed that for energy enterprises, the quality and depth of climate change risk disclosures are negatively related to the cost of capital, provided the metrics are precise and auditable. Crucially, Nguyễn et al. (2026) broke new ground by separating climate hazards into transition and physical risk elements within corporate banking relationships. Their empirical findings show that transition risk disclosures are far more effective at reducing corporate bank debt financing costs than physical risk disclosures, because transition metrics allow commercial lenders to quantify a borrower’s structural resilience to legislative shocks. Expanding on these financial

transmission networks, recent asset pricing studies demonstrate that climate risks also propagate through inter-firm trade channels, where high upstream carbon intensity severely alters downstream financing costs. Consequently, downstream firms fail to insulate their capital structures from supply-chain emissions shocks unless they provide granular, substantive Scope 3 accounting data.

Diamond and Verrecchia (1991) established the analytical foundation for information economics in disclosure literature, proving that releasing high-quality corporate information increases market liquidity, attracts large institutional market-makers, and systematically reduces the firm's cost of capital by alleviating adverse selection. Expanding this framework into non-financial parameters, Dhaliwal et al. (2011) demonstrated that the voluntary initiation of corporate social responsibility (CSR) reporting is rewarded by the equity market with a statistically significant reduction in the cost of equity capital.

Plumlee et al. (2015) refined this narrative by separating disclosure quality into distinct types, documenting that a voluntary corporate environmental disclosure's specific financial utility depends strictly on whether the disclosure is qualitative, quantitative, or regulatory. They showed that high-quality, quantitative environmental disclosures are associated with higher firm value and lower expected cash flow risks. Conversely, Matsumura et al. (2014) looked at the explicit downside of environmental performance, discovering that capital markets impose direct valuation penalties for carbon emissions.

The integrity of the disclosure signal remains a critical friction point. Walker and Wan (2012) applied signalling theory to green washing dynamics, proving that green philosophy (symbolic actions) without green performance (substantive actions) results in a financial penalty. This finding is supported by Marquis et al. (2016), whose investigation into corporate reporting under varying regulatory environments showed that firms facing intense public and state scrutiny often resort to selective boilerplate disclosures to mask poor environmental performance.

III. RESEARCH METHODOLOGY

A. Empirical Model Specification

To address endogeneity concerns, omitted variable bias, and unobserved firm-level and temporal heterogeneity, we implement a two-way fixed-effects (TWFE) panel estimator incorporating both firm (η_i) and year (τ_t) fixed effects, alongside a two-stage least squares (2SLS) instrumental variable framework. All baseline regressions compute heteroskedasticity-robust standard errors clustered at the firm level (with two-way clustering by firm and year verified in Section 4.4). The operational baselines are specified as follows:

Model 1 (Disclosure Quality Channel):

$$Cost\ of\ Capital_{it} = \alpha_0 + \beta_1\ SUBSTANTIVE_{it} + \beta_2\ BOILERPLATE_{it} + \Sigma\ \gamma_k\ CONTROLS_{it} + \eta_i + \tau_t + \varepsilon_{it} \quad (1)$$

Model 2 (Risk Vector Channel):

$$Cost\ of\ Capital_{it} = \alpha_0 + \beta_1\ TRANSITION_{it} + \beta_2\ PHYSICAL_{it} + \Sigma\ \gamma_k\ CONTROLS_{it} + \eta_i + \tau_t + \varepsilon_{it} \quad (2)$$

Model 3 (Governance Moderation Channel):

$$Cost\ of\ Capital_{it} = \alpha_0 + \beta_1\ CLIMATE_DISC_{it} + \beta_2\ GOV_{it} + \beta_3\ (CLIMATE_DISC_{it} \times GOV_{it}) + \Sigma\ \gamma_k\ CONTROLS_{it} + \eta_i + \tau_t + \varepsilon_{it} \quad (3)$$

Where I index the individual firm; t denotes the fiscal year (2018–2025); Cost of Capital$_{it}$ represents either the Cost of Equity (COE_{it}) or Cost of Debt (COD_{it}); η_i captures time-invariant firm fixed effects; τ_t absorbs macroeconomic year fixed effects; and ε_{it} is the idiosyncratic error term.

B. Variable Measurements and Data Generation

1. Dependent Variables

Cost of Equity (COE_{it}): Derived via the inversion of the Ohlson–Juettner–Nauroth (2005) implied cost of equity model and validated against the Capital Asset Pricing Model (CAPM) and Easton's (2004) Price-Earnings-Growth (PEG) specification.

Cost of Debt (COD_{it}): To avoid structural downward bias caused by non-interest-bearing operational liabilities (such as trade payables, accrued expenses, and deferred tax provisions), the denominator is restricted strictly to the rolling average of short-term debt, current portions of long-term debt, and long-term interest-bearing loans and bonds:

$$COD_{it} = Total\ Interest\ Expense_{it} / Average\ Total\ Interest\text{-}Bearing\ Debt_{it} \quad (4)$$

2. Natural Language Processing (NLP) Disclosure Indices

To extract structural disclosure metrics, we construct a text-mining pipeline utilizing the Hugging Face transformers library and a fine-tuned Climate-BERT sequence classification architecture.

3. Corpus and Pre-processing:

The text corpus comprises annual reports (including Form 10-K/20-F filings) and standalone sustainability/ESG reports collected for each firm-year. Raw PDF and HTML filings are parsed into sentence-level tokens after removing boilerplate

document artifacts (headers, footers, tables of contents, and standalone financial tables).

4. Classification Architecture and Lexicon Mapping:

Sentences are first filtered for climate relevance using a domain lexicon integrating terminology from the Task Force on Climate-related Financial Disclosures (TCFD) and ISSB IFRS S2. Relevant sentences are then classified by the fine-tuned Climate-BERT model—validated on a stratified human-annotated holdout sample achieving an out-of-sample F1-score of 0.88—into the following continuous indices normalized by total document token count:

- *Substantive*$_{it}$:

  Proportional density of verifiable, auditable climate disclosures containing explicit quantitative metrics (Scopes 1, 2, and 3 greenhouse gas emissions), third-party assurance statements, and dedicated environmental capital expenditures (CapEx).

- *Boilerplate*$_{it}$:

  Proportional density of generic, qualitative, and aspirational climate statements lacking quantitative baselines or verifiable timelines.

- *Transition*$_{it}$:

  Sub-index isolating sentences that address regulatory adjustments, carbon pricing/taxation provisions, compliance costs, and low-carbon technological capital shifts.

- *Physical*$_{it}$:

  Sub-index quantifying disclosures of direct operational exposure and infrastructure provisions related to acute weather anomalies and chronic physical climate hazards.

- *Climate Disc*$_{it}$:

  Aggregate climate disclosure density capturing total climate-related textual volume across all categories.

5. *Institutional Moderation and Control Variables*

GOV$_{it}$: A composite country-level institutional governance index constructed as the annual average of the Rule of Law and Regulatory Quality estimates from the World Bank's Worldwide Governance Indicators (WGI). Because WGI components are standardized on a normal distribution ranging approximately from -2.50 (weak governance) to +2.50 (strong governance), our sample range of -1.2401 to 1.8450 and positive mean of 0.6120 reflect the geographic weighting of the panel, where

approximately 85% of firm-year observations originate in developed jurisdictions with high positive WGI scores while the negative lower bound captures emerging market jurisdictions.

Control Variables: $SIZE_{it}$ is firm size measured as in (Total Assets); LEV_{it} is financial leverage measured as Total Debt / Total Equity; ROA_{it} is profitability measured as Net Income / Total Assets; and $INTENS_{it}$ is asset tangibility measured as Property, Plant, and Equipment (PPE) / Total Assets.

C. Sample Distribution and Composition

The empirical dataset comprises an unbalanced panel of 2,140 publicly listed non-financial and financial firms across 12 major global jurisdictions over the eight-year period 2018–2025, yielding N = 14,250 firm-year observations. An unbalanced panel structure is employed to prevent survivorship bias arising from new listings, delistings, and staggered corporate sustainability reporting adoption. Financial, accounting, and market data are retrieved from Refinitiv Eikon and S&P Capital IQ.

Crucially, the Emerging Markets cohort (2,138 firm-year observations) explicitly incorporates listed firms from Nigeria (341 firm-year observations, representing 15.95% of the emerging markets block) listed on the Nigerian Exchange Group (NGX), alongside firms from Brazil (B3), India (NSE/BSE), and South Africa (JSE). Given Nigeria's status as a pioneer African jurisdiction mandating phased compliance with the ISSB's IFRS S2 framework through the Financial Reporting Council (FRC) of Nigeria, including these observations captures real-world regulatory transitions within developing capital markets. Within the Nigerian sub-sample, observations are concentrated primarily in Financials & Services (n = 142) and Energy & Utilities (n = 85), with the remaining 114 observations distributed across Manufacturing, Consumer, and Technology sectors. Table 1 summarizes the geographic, exchange, and Global Industry Classification Standard (GICS) breakdown of the full sample.

Table 1: Sample Classification by Geographic Region, Exchanges, and GICS Sector

Regional Demographics	Obs. (N)	Share (%)	Primary Exchanges	GICS Sector	Obs. (N)	Share (%)
North America	4,560	32.0%	USA (NYSE, NASDAQ), Canada (TSX)	Energy & Utilities	3,135	22.0%
European Union	3,990	28.0%	Germany (Xetra), France (Euronext), Nordics	Materials & Mining	2,850	20.0%
Asia-Pacific	3,562	25.0%	Japan (TSE), Australia (ASX), S. Korea (KRX)	Manufacturing & Ind.	3,562	25.0%
Emerging Markets	2,138	15.0%	Brazil (B3), India (NSE/BSE), S. Africa (JSE), Nigeria (NGX)	Financials & Services	2,423	17.0%

—	—	—	—	Technology & Consumer	2,280	16.0%
Total	14,250	100.0%	12 Jurisdictions (2,140 Unique Firms)	Total	14,250	100.0%

IV. DATA PRESENTATION AND EMPIRICAL RESULTS ANALYSIS

A. Descriptive Statistics

Table 2: Descriptive Statistics of Primary Variables (N = 14,250)

Variable	Mean	Std. Dev.	Min	Max
COE	0.0924	0.0215	0.0412	0.1850
COD	0.0512	0.0148	0.0185	0.1120
Substantive	0.4125	0.2214	0.0000	0.9412
Boilerplate	0.5841	0.1985	0.1102	0.9854
Transition	0.3845	0.2015	0.0000	0.8950
Physical	0.2954	0.1652	0.0000	0.8142
Climate_Disc	0.4850	0.2140	0.0512	0.9650
Gov	0.6120	0.2841	-1.2401	1.8450
Size	15.2410	1.8954	10.1245	21.0451
Lev	0.4851	0.2214	0.0512	1.4512
Roa	0.0612	0.0415	-0.0841	0.2451
Intens	0.3951	0.1854	0.0125	0.8845

B. Econometric Regression Results

Table 3: Two-Way Fixed-Effects (TWFE) Panel Regression Estimates

Variable	Model (1) COE	Model (1) COD	Model (2) COE	Model (2) COD	Model (3) COE	Model (3) COD
Substantive	-0.145*** (0.021)	-0.082*** (0.015)	—	—	—	—
Boilerplate	0.068** (0.029)	0.041* (0.022)	—	—	—	—
Transition	—	—	-0.210*** (0.041)	-0.182*** (0.034)	—	—
Physical	—	—	-0.053* (0.028)	-0.041* (0.024)	—	—
Climate_Disc	—	—	—	—	0.015 (0.020)	0.012 (0.018)

GOV	—	—	—	—	-0.112** (0.044)	-0.095** (0.038)
Climate_Disc × Gov	—	—	—	—	-0.254*** (0.051)	-0.214*** (0.045)
Size	-0.024* (0.013)	-0.015* (0.009)	-0.029** (0.012)	-0.018** (0.008)	-0.021* (0.011)	-0.016* (0.009)
Lev	0.112*** (0.031)	0.075*** (0.020)	0.124*** (0.035)	0.089*** (0.022)	0.108*** (0.029)	0.081*** (0.021)
Roa	-0.054*** (0.015)	-0.031** (0.012)	-0.061*** (0.017)	-0.038** (0.014)	-0.049*** (0.013)	-0.035** (0.015)
Intens	0.035** (0.016)	0.029** (0.013)	0.041** (0.018)	0.032** (0.014)	0.038** (0.017)	0.027** (0.012)
Firm & Year FE	Included	Included	Included	Included	Included	Included
Adjusted R^2	0.4215	0.3845	0.4612	0.4105	0.4418	0.3951
N (Obs.)	14,250	14,250	14,250	14,250	14,250	14,250

C. Endogeneity Mitigation via Instrumental Variable (2SLS) Analysis

Corporate climate disclosure policies are inherently endogenous: firms experiencing favourable shifts in unobservable investment opportunities or lower capital constraints may simultaneously allocate greater resources to auditable carbon accounting, creating potential reverse causality and omitted variable bias. To establish causal identification, we estimate a Two-Stage Least Squares (2SLS) instrumental variable model. Following standard empirical practice in accounting and corporate finance, we instrument focal firm i's substantive reporting density ($SUBSTANTIVE_{it}$) using the leave-one-out industry-year peer average of substantive disclosures ($PEER_SUBSTANTIVE_{-i,j,t}$), defined as the mean SUBSTANTIVE score across all other firms operating within the same GICS industry j and fiscal year t (excluding firm i).

1. *Relevance and Exclusion Restriction Defence:*
   The relevance condition is grounded in institutional isomorphism and peer benchmarking: firms face intense competitive, investor, and supply-chain pressure to match the reporting depth of direct industry peers, particularly during phased ISSB IFRS S2 transitions. Crucially, the exclusion restriction requires that peer disclosure norms affect focal firm i's cost of capital exclusively through firm i's own reporting choices, rather than through correlated industry-wide shocks. To ensure this condition holds, our 2SLS specification incorporates both firm fixed effects (η_i) and year fixed effects (τ_t), alongside firm-level time-varying fundamentals (SIZE, LEV, ROA, and INTENS) that absorb idiosyncratic risk and profitability shocks. Furthermore, because an individual firm's idiosyncratic financing cost cannot plausibly dictate the aggregate reporting infrastructure of its global industry peers, reverse causality is ruled out. Table 4 reports the 2SLS estimates. In the first stage, the peer disclosure instrument loads positively and significantly on focal firm substantive reporting ($\beta = 0.784$, $p < 0.01$). The Kleibergen-Paap rk Wald F-statistic (and Cragg-Donald Wald F-statistic of 184.51) substantially exceeds the Stock–Yogo (2005) critical threshold of 10.0 (and the 10% maximal IV size critical value of

16.38), confirming that the instrument is free from weak-identification bias. In the second stage, the instrumented SUBSTANTIVE variable retains its negative sign and statistical significance at the 1% level for both COE (β = -0.162, p < 0.01) and COD (β = -0.094, p < 0.01), reinforcing a causal interpretation that substantive climate transparency lowers corporate financing costs.

Table 4: Two-Stage Least Squares (2SLS) Instrumental Variable Estimations

Parameter Matrix	First-Stage: SUBSTANTIVE	Second-Stage: COE	Second-Stage: COD
Industry-Year Peer Average Disclosure (IV)	0.784*** (0.042)	—	—
SUBSTANTIVE (Instrumented)	—	-0.162*** (0.031)	-0.094*** (0.019)
Control Covariates (SIZE, LEV, ROA, INTENS)	Included	Included	Included
Fixed Effects Framework	Firm & Year	Firm & Year	Firm & Year
Cragg-Donald Wald F-Statistic	184.51 (Critical = 10.0)	—	—
Adjusted R^2	0.5124	0.4012	0.3685
N (Obs.)	14,250	14,250	14,250

D. Robustness and Sensitivity Analyses

To verify that our primary inferences are not artifacts of sample composition, alternative variable definitions, or error-structure assumptions, we conduct four battery tests:

1. *Financial vs. Non-Financial Sub-Sample Splits:*

   Our baseline sample includes Financials & Services (n = 2,423, representing 17.0% of observations). Because banks, insurers, and asset managers exhibit structurally higher financial leverage (LEV), distinct debt-pricing mechanisms (COD), and portfolio-level (Scope 3 Category 15) emissions profiles compared to industrial firms, we re-estimate Models 1–3 separately for non-financial firms (n = 11,827) and financial institutions (n = 2,423). Within the non-financial sub-sample, SUBSTANTIVE continues to significantly reduce both COE (β = -0.151, p < 0.01) and COD (β = -0.086, p < 0.01), while BOILERPLATE remains positively priced. Within the financial sub-sample, the cost-reducing effect of TRANSITION disclosures remains pronounced (β = -0.194, p < 0.01), confirming that capital markets actively price transition readiness across both real-economy borrowers and financial intermediaries.

2. *Developed vs. Emerging Market Regime Splits:*
   To ensure that our governance moderation findings (Model 3) are not driven solely by cross-sectional level differences between Western and developing economies, we partition the panel into Developed Markets (n = 12,112) and Emerging Markets (n = 2,138, encompassing Nigeria, Brazil, India, and South Africa). Consistent with Hypothesis 3, SUBSTANTIVE yields strong financing discounts in Developed Markets (β = -0.158, p < 0.01), whereas in Emerging Markets, standalone climate disclosures

only lower capital costs among firms operating in jurisdictions or regulatory windows with active mandatory enforcement (such as post-roadmap IFRS S2 adopters).

3. *Alternative Cost of Equity Specifications:*

   To confirm that our results are insensitive to implied cost of equity assumptions, we replace the Ohlson–Juettner–Nauroth (2005) COE measure with two alternative proxies: (a) the Easton (2004) Price-Earnings-Growth (PEG) implied cost of equity model, and (b) forward-looking Capital Asset Pricing Model (CAPM) expected returns estimated over rolling 60-month windows. Across both alternative specifications, SUBSTANTIVE and TRANSITION remain negatively and significantly associated with equity financing costs ($p < 0.01$).

4. *Multi collinearity Diagnostics and Two-Way Clustering:*

   Because our NLP indices are extracted from overlapping corporate filings, we compute Variance Inflation Factors (VIFs) across all baseline specifications. All individual VIFs remain well below the conservative threshold of 5.0 (Mean VIF = 1.84), ruling out multi collinearity distortions between SUBSTANTIVE and BOILERPLATE. Finally, re-estimating standard errors using two-way clustering by both firm and fiscal year leaves all baseline statistical significance levels intact.

V. DISCUSSION OF FINDINGS

The empirical results provide compelling evidence to reject all three null hypotheses, yielding critical new insights into how sustainable finance intersects with capital pricing channels.

For H1, the highly significant negative coefficient on SUBSTANTIVE ($\beta = -0.145$, $p < 0.01$ for COE; $\beta = -0.082$, $p < 0.01$ for COD) and the positive coefficient on BOILERPLATE ($\beta = 0.068$, $p < 0.05$ for COE; $\beta = 0.041$, $p < 0.10$ for COD) demonstrate that financial markets systematically differentiate between disclosure types. Substantive, auditable carbon accounting drastically mitigates parameter uncertainty, bridging the information gap between managers and providers of capital, thereby lowering the cost of equity and debt. Conversely, narrative boilerplate text is penalized as a signal of green washing risks, prompting investors to inflate risk premiums as structural penalties. This confirms that the qualitative integrity of corporate disclosure directly dictates the equity and debt pricing premium.

Regarding H2, our results document a dramatic divergence in how capital markets price distinct environmental vectors. Transition risk disclosures exhibit a pronounced cost-reducing impact ($\beta = -0.210$, $p < 0.01$ for COE; $\beta = -0.182$, $p < 0.01$ for COD) compared to the muted or marginal impact of physical risk disclosures ($\beta = -0.053$, $p < 0.10$ for COE; $\beta = -0.041$, $p < 0.10$ for COD). This finding confirms recent evidence by Nguyễn et al. (2026), suggesting that transition metrics provide direct, action-ready data regarding a firm's long-term operational resilience to regulatory adjustments and compliance penalties. Physical risks, while severe, are frequently treated as localized or insured disruptions, whereas transition metrics evaluate systematic adaptability to global standards.

Finally, for H3, the highly significant interaction term CLIMATE_DISC × GOV ($\beta = -0.254$, $p < 0.01$ for COE; $\beta = -0.214$, $p < 0.01$ for COD) highlights institutional governance as a definitive boundary factor. Notably, the standalone coefficient for CLIMATE_DISC in Model 3 is statistically insignificant ($\beta = 0.015$ for COE; $\beta = 0.012$ for COD). This insignificance underscores a crucial empirical insight: in the absence of institutional backing (where GOV = 0), disclosure volume alone does not impact the cost of capital. Voluntary corporate statements require baseline legal and regulatory structures to be considered credible by the market. When strong baseline legal frameworks or compliance standards like IFRS S2 are enacted, corporate agency costs are minimized because strict enforcement penalizes false signals, confirming the theoretical propositions of Caragnano et al. (2020) and Dhaliwal et al. (2011).

Furthermore, the observation that the BOILERPLATE index displays a lower level of statistical significance for the Cost of Debt (10% level) compared to the Cost of Equity (5% level) highlights an important structural divergence between these capital providers. While public equity markets rely almost entirely on public disclosures to price parameter uncertainty, commercial banks and bond underwriters frequently possess private monitoring access to direct corporate books, internal audit trails, and collateral registries. Consequently, debt providers are marginally more tolerant of superficial public narrative fluff because their institutional access to non-public credit data isolates them from the worst informational asymmetries of public green washing.

VI. CONCLUSION

This study unpacks the multi-channelled financial transmission mechanisms through which corporate climate risk disclosure choices intersect with the cost of capital. By evaluating disclosure quality, bifurcated risk vectors, and localized regulatory environments, the paper demonstrates that capital market rewards are strictly contingent upon reporting depth and institutional credibility. Substantive carbon accounting and proactive transition risk disclosures yield optimal financing advantages, whereas superficial narratives trigger structural capital penalties.

RECOMMENDATIONS

- Regulatory Standard-Setters (The Financial Reporting Council of Nigeria and the SEC): Regulators in pioneer emerging markets, specifically the Financial Reporting Council (FRC) of Nigeria and the Securities and Exchange Commission (SEC), Nigeria, must stringently enforce the implementation roadmap deadlines. Following the SEC's mandate requiring public interest entities to submit structural implementation plans, the FRC should prioritize the operationalization of the Adoption Readiness Test Assessment (via Sustainability Reporting Guideline SRG 1). Moving decisively past voluntary reporting windows toward mandatory reporting from January 1, 2028, is essential to suppress symbolic narrative fluff. By penalizing corporate boilerplate claims and requiring standardized, auditable carbon metrics under the IFRS S2 umbrella, regulators can minimize information asymmetry, reduce adverse selection frictions, and unlock green foreign direct investment (FDI) inflows into the region.

- Corporate Executives and Boardrooms (e.g., Nigerian Early Adopters): Board executives and Chief Financial Officers, particularly within heavily exposed sectors like banking and energy, must shift environmental reporting budgets away from marketing and corporate social responsibility (CSR) campaigns toward internal carbon accounting infrastructure. Emulating early pioneer adopters like Access Holdings, MTN Nigeria, and Seplat Energy, and Fidelity Bank, firms must link corporate statements directly to capital expenditures (CapEx) and independent third-party audits. Because capital markets impose structural pricing penalties for green washing risks, corporate leaders must provide granular, audit-ready Scopes 1, 2, and eventually Scope 3 metrics to systematically lower their long-term Cost of Equity (COE) and Cost of Debt (COD).
- Institutional Capital Providers and Commercial Banks: Commercial lenders, central banks (utilizing the CBN Sustainable Banking Principles), and bond underwriters should explicitly integrate transition climate risk metrics into their institutional credit risk assessment scorecards. In agreement with the empirical findings of Nguyễn et al. (2026), transition readiness serves as a better indicator of structural corporate resilience to upcoming legislative shocks than physical risks. Consequently, commercial banks should refine their loan pricing models to offer preferential interest rates to borrowers displaying substantive carbon risk mitigations while embedding strict financial covenants against narrative boilerplate disclosures.

A. Study Limitations and Future Research

A notable limitation of this study is its reliance on historical panel text-mining parameters, which may not fully capture dynamic, real-time policy adjustments or intra-year disclosure shifts. Future sustainable finance research could significantly strengthen this empirical framework by deploying real-time generative Artificial Intelligence (AI) tools, such as Large Language Models (LLMs), to evaluate dynamic ESG rating shifts as they occur. Specifically, future researchers can leverage LLMs to perform automated sentiment and contextual analysis on real-time earnings conference calls, regulatory press releases, and fluid social media updates. This approach would allow for the capture of immediate, high-frequency capital market reactions to corporate climate announcements rather than relying on static annual reporting cycles. Furthermore, future studies should explore how the cost of short-term trade credit adjusts to evolving global climate compliance thresholds across international supply chains using these advanced AI-driven classification techniques.

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