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THE RESILIENCE PREMIUM: A MULTI-DIMENSIONAL ANALYSIS OF HOW ESG PERFORMANCE DE-RISKS SUPPLY CHAINS TO OPTIMIZE DEBT FINANCING COSTS

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Abstract
As global capital markets increasingly internalize the systemic externalities of production, the nexus between Environmental, Social, and Governance (ESG) performance and the cost of debt financing has emerged as a critical frontier in corporate finance. This paper provides a comprehensive theoretical synthesis and conceptual modelling of how ESG integration serves as a strategic mechanism for mitigating financing costs through the lens of supply chain management. By integrating Signalling Theory, Stakeholder Theory, and Information Asymmetry Theory, we develop a multi-dimensional framework that identifies three primary transmission channels, the Information Channel, the Operational Resilience Channel, and the Reputational Channel. Unlike traditional empirical studies, this research utilizes a meta-synthesis of contemporary literature and conceptual graphical modelling to illustrate the "Resilience Premium"—a phenomenon where superior sustainability practices function as implicit collateral. We analyze the ESG profiles of global market leaders, such as Microsoft, Apple, and Walmart, as illustrative case benchmarks to validate our theoretical propositions. The study introduces the ESG-Risk Spread Curve to demonstrate a non-linear "threshold effect" in debt pricing. Our findings conclude that proactive ESG integration is a fundamental financial imperative that optimizes a firm's capital structure by de-risking its entire production ecosystem, offering a robust theoretical foundation for future empirical testing.
Keywords: *ESG Performance, Cost of Debt, Supply Chain Resilience, Information Asymmetry, Credit Risk, Sustainable Finance*

INTRODUCTION

The global financial landscape is currently undergoing a transformative shift from shareholder primacy to stakeholder capitalism, a transition that has elevated Environmental, Social, and Governance (ESG) criteria from peripheral ethical considerations to core determinants of corporate valuation and risk profile. Historically, corporate finance models focused almost exclusively on idiosyncratic financial ratios—such as leverage, liquidity, and profitability—to determine the creditworthiness of an enterprise. However, as DiMaggio and Powell (1983) suggested through Institutional Theory, organizations are increasingly pressured to adopt socially responsible behaviors to achieve legitimacy within their fields. In the contemporary era, this legitimacy is directly tied to a firm's ability to manage its environmental footprint, social obligations, and governance structures. The cost of debt financing, representing the interest rate a firm must pay to its lenders, is perhaps the most sensitive barometer of a firm's perceived risk. Unlike equity holders, who participate in the upside potential of a firm, debt holders are primarily concerned with downside risk or the probability of default (Merton, 1974). Consequently, anything that reduces the volatility of a firm's cash flows or limits its exposure to systemic shocks is highly valued by creditors. This is where the supply chain becomes the focal point of the ESG-debt nexus. In a globalized economy, a firm's operations are no longer contained within its own walls; they are distributed across a complex web of international suppliers and distributors (Marc et al., et al., 2022; Khalid et al., 2025; Siddique et al., 2025). As a result, a firm's ESG performance is only as strong as the weakest link in its supply chain.

The modern supply chain serves as a primary transmission mechanism for both operational and financial risk. As identified by Xu et al. (2025), supply chain disruptions caused by environmental disasters, labor strikes, or governance failures can lead to immediate halts in production, resulting in liquidity crunches that impair a firm's ability to service its debt obligations. From a financial perspective, this is often characterized by Information Asymmetry Theory (Leland & Pyle, 1977). Lenders often possess incomplete information regarding the hidden risks within a borrower's supply chain. When a firm proactively engages in ESG reporting and sustainable supply chain management (SSCM), it acts as a signal to the market (Spence, 1973), reducing the information gap and allowing lenders to price risk more accurately—and often more favorably.

The social (S) component of ESG within the supply chain is particularly critical in the current geopolitical climate. Issues such as modern slavery, child labor, and poor working conditions in upstream tiers of the supply chain can

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lead to reputational contagion. This phenomenon occurs when a supplier's scandal spills over onto the lead firm, leading to consumer boycotts, loss of brand equity, and, crucially, a spike in the firm's perceived default risk (Audi et al., 2021; Priem & Gabellone, 2024; Mehdi et al., 2025). Lenders, wary of such social shocks, increasingly apply a risk premium to firms that lack transparent social oversight in their supply chains.

Environmental factors have transitioned from moral obligations to quantifiable financial liabilities (Audi & Al Masri, 2024; Abbasi et al., 2025; Arshad et al., 2025; Farras et al., 2025). The emergence of the Transition Risk concept describes the potential for carbon taxes, green regulations, and shifts in consumer preferences to strand assets and bankrupt firms that are heavily reliant on carbon-intensive supply chains. Huang and Zhang (2025) note that banks are now incorporating climate stress tests into their credit models. Firms that demonstrate superior environmental performance through carbon footprint reduction and climate-resilient sourcing are rewarded with lower interest rates. This is because these firms are seen as being future-proofed against the inevitable regulatory shifts of a net-zero global economy (Marc, 2024; Iqbal et al., 2025; Arshi et al., 2025; Batool et al., 2025).

Furthermore, the physical risks of climate change—such as extreme weather events—pose a direct threat to the physical infrastructure of the supply chain (Audi & Yu, 2024; Zahid et al., 2025; Rafique et al., 2025). A firm with a highly concentrated supply chain in a region vulnerable to climate events faces a higher probability of cash flow volatility. By integrating ESG metrics, firms can diversify their sourcing and improve their Environmental Resilience, a trait that creditors reward with tighter credit spreads (Marc & Ali, 2018; Umair et al., 2025; Shaukat et al., 2025).

Governance (G) is the bedrock upon which the E and S pillars are built. Without robust governance structures, environmental and social initiatives are often relegated to greenwashing. From a debt financing perspective, governance is closely tied to Agency Theory. Creditors are concerned that management might engage in moral hazard by taking excessive risks or misallocating resources. Strong ESG governance ensures that there is board-level oversight of supply chain risks, which reduces the monitoring costs for lenders (Audi, 2016; Li & Wang, 2025; Naeem et al., 2025; Iqbal et al., 2025).

A firm with high governance scores is perceived as having a more ethical corporate culture, which reduces the risk of fraud, corruption, and mismanagement—all of which are precursors to financial distress (Ali et al., 2025; Zafar et al., 2025; Ullah et al., 2025). In the supply chain, this translates to ethical contract management and transparent relationship-building with suppliers, ensuring that the firm remains a preferred buyer even during periods of economic contraction (Audi et al., 2021; Ali et al., 2025; Karim et al., 2025; Khalid et al., 2025).

Despite the growing body of literature on ESG, there remains a significant gap in understanding the specific pathways through which supply chain dynamics mediate the relationship between sustainability and debt costs. While some studies suggest a direct linear relationship, others, such as Shalhoob and Hussainey (2023), indicate a threshold effect, where financial benefits only materialize once a firm reaches a critical level of ESG maturity.

This research seeks to bridge this gap by examining the following critical questions: How does supply chain transparency influence the ESG discount in corporate bond markets? To what extent does supply chain concentration moderate the impact of ESG performance on the cost of bank loans? Can sustainable supply chain management serve as a form of implicit collateral that lowers interest rates during periods of market volatility?

By addressing these questions, this study provides a multi-dimensional framework that integrates Institutional, Stakeholder, and Financial Theories. The goal is to prove that ESG is not merely a cost of doing business, but a strategic investment that optimizes the firm's capital structure by de-risking its entire operational ecosystem.

LITERATURE REVIEW

The relationship between Environmental, Social, and Governance (ESG) performance and the cost of debt financing has emerged as a cornerstone of modern financial research. As global supply chains face increasing scrutiny from regulators and investors, the ability of a firm to demonstrate sustainability throughout its value chain has direct implications for its creditworthiness. This review synthesizes twenty seminal articles to elucidate how ESG metrics serve as a mechanism for risk mitigation and cost reduction in debt markets.

Cheng, He, and Tang (2025) provide a foundational exploration of this relationship through the lens of Signalling Theory. By analysing a longitudinal dataset of S&P 500 companies, the authors demonstrate that superior ESG scores act as a high-quality signal of management competence and long-term operational viability. From a supply chain perspective, this signal is critical because it reduces the information risk premium that lenders typically charge. The study emphasizes that while the governance pillar offers the most immediate feedback for bond pricing, the environmental and social pillars act as long-term insurance against systemic supply chain disruptions.

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Building on this, Xu et al. (2025) explicitly identify the supply chain transmission channels that bridge ESG performance and interest rates. Using data from Chinese A-share listed enterprises, they uncover that ESG excellence facilitates lower debt costs primarily through two mechanisms: supplier stability and customer concentration. Their findings suggest that ethical firms attract more resilient suppliers and maintain a more diversified customer base, which stabilizes cash flows and provides a form of relational collateral. This operational stability allows firms to negotiate more favorable loan terms with commercial banks.

Li and Wang (2025) shift the focus to supply chain financing, arguing that ESG performance is no longer a peripheral consideration but a core eligibility criterion for modern credit platforms. Their research indicates that firms with transparent ESG disclosures experience significantly lower levels of information asymmetry. This transparency allows financial institutions to offer lower-cost trade credit, particularly in high-tech sectors where intellectual property and supply chain continuity are paramount. The study concludes that ESG compliance serves as a green pass for securing liquidity within complex production networks.

Shi (2024) offers a comprehensive analysis of both formal bank loans and informal trade credit. Utilizing Latent Dirichlet Allocation to analyse the thematic depth of corporate reports, Shi finds that the ESG discount is highly sensitive to the quality of disclosure. Suppliers are notably more willing to extend generous payment terms to buyers who demonstrate high social responsibility, effectively reducing the buyer's implicit cost of debt. This research highlights that the financial benefits of ESG are pervasive, affecting every tier of the credit market within the supply chain.

Zhou et al. (2024) investigate the moderating role of independent assurance in the ESG-debt nexus. They argue that the credibility of ESG data is a primary concern for creditors. Their empirical evidence suggests that third-party audits of ESG reports significantly amplify the negative relationship between sustainability performance and debt costs. For supply chain managers, this implies that verifying the ESG credentials of upstream partners is essential to maintaining the firm's own credit rating and minimizing interest expenses.

In the context of environmental volatility, Huang and Zhang (2025) examine how climate risk management—as a component of the E pillar—influences debt management. They find that firms with robust environmental strategies are better equipped to navigate climate-related supply chain shocks. Lenders perceive these firms as having lower tail risks, leading to reduced spreads on corporate bonds. The study provides empirical proof that climate resilience is now a quantifiable factor in credit stress testing performed by major global banks.

Zhao and Sun (2025) explore the interaction between supply chain concentration and ESG performance. Traditionally, a high concentration of suppliers is viewed as a financial risk by creditors. However, Zhao and Sun demonstrate that high ESG performance acts as a buffer, mitigating the negative financial impact of such concentration. By fostering ethical relationships with key partners, firms reduce the likelihood of sudden supply chain breaks, which in turn lowers the risk premium demanded by lenders.

De Goeij et al. (2024) analyse the rise of Sustainability-Linked Supply Chain Finance (SSCF). Their research illustrates a dynamic financial ecosystem where lead firms with high ESG ratings leverage their status to lower the borrowing costs of their suppliers. This virtuous liquidity cycle ensures that the entire supply chain remains financially viable. The authors conclude that firms participating in SSCF programs enjoy more stable credit ratings and lower weighted average costs of capital.

Khan et al. (2025) address the problem of ESG rating disagreement. They find that when different rating agencies provide conflicting scores, lenders charge an uncertainty premium. However, firms that provide granular, standardized ESG data throughout their supply chains are able to resolve this ambiguity. This research underscores the importance of data consistency in the supply chain for firms seeking to optimize their debt financing costs.

Chen and Liu (2024) focus on heavy-polluting industries, where the financial stakes of ESG are highest. They find that for these firms, ESG performance is the single most important factor in determining credit accessibility. By investing in green supply chain innovation, these firms reduce their regulatory and litigation risks. Lenders view these investments as a sign of future-proofing, which justifies lower interest rates on long-term project financing.

Niranjala and Jianguo (2025) examine the impact of ESG on Small and Medium Enterprises (SMEs) within global value chains. They find that for SMEs, ESG disclosure acts as a reputation substitute for traditional collateral. By meeting the ESG requirements of their large multinational buyers, SMEs can access bank loans at rates that were previously unavailable to them. This study highlights the democratizing effect of ESG in supply chain financing.

Helmold (2024) integrates Sustainable Supply Chain Management (SSCM) with corporate governance. He argues that creditors evaluate firms as extended enterprises. Firms that fail to monitor the social and environmental

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conduct of their suppliers are seen as having significant governance gaps. Helmold's data shows that robust SSCM practices lead to a measurable reduction in bond yields, as lenders price in the lower risk of reputational scandals.
Wang and Zhang (2024) explore how intelligent supply chains—powered by AI and IoT—enhance the ESG-debt relationship. They find that real-time verification of ESG metrics eliminates much of the monitoring cost for banks. This technological transparency allows firms to secure Sustainability-Linked Loans (SLLs) with interest rates that drop automatically as the firm achieves its sustainability targets.
Zhang et al. (2024) utilize DuPont analysis to break down the financial impact of ESG. They find that ESG excellence improves asset turnover and operational efficiency within the supply chain. These fundamental improvements lead to stronger interest coverage ratios, which directly lower the firm's cost of debt. The study confirms that ESG performance is a core driver of financial health, rather than a mere philanthropic expense.
Liu and Wang (2022) discuss the institutional impact of Green Credit Policies (GCP). They find that government mandates in certain regions force banks to offer preferential rates to high-ESG firms. This creates a cascading financial incentive throughout the supply chain, as lead firms pressure their suppliers to adopt green practices to maintain their access to low-cost capital.
Priem and Gabellone (2024) investigate the role of corporate reputation. They argue that the Social (S) pillar of ESG builds a reservoir of goodwill that protects firms during financial downturns. Lenders are more likely to offer flexible terms to firms with high social responsibility scores, as these firms are viewed as being more resilient to Labor unrest and community backlash.
Apergis et al. (2022) focus on the Western European market, analysing Credit Default Swap (CDS) spreads. They find that ESG scores are inversely related to the cost of default insurance. In the EU, where supply chain due diligence is a legal requirement, ESG performance serves as a proxy for compliance readiness, leading to significantly lower financing costs for compliant firms.
Raimo et al. (2021) offer a sector-specific study on the maritime industry. Given the capital-intensive nature of shipping, the authors find that ESG transparency is essential for accessing Blue Bonds and other specialized debt instruments. Shipping firms that manage their environmental footprint effectively are rewarded with lower spreads, ensuring their continued role as viable enablers of global trade.
Zumente and Bistrova (2021) provide a qualitative perspective from bank credit officers. Their interviews reveal that lenders view ESG as a proxy for management quality. In the complex world of supply chain logistics, a management team that handles ESG issues effectively is perceived as being better equipped to handle financial risks, resulting in higher internal credit ratings.
Finally, Shalhoob and Hussainey (2023) identify a threshold effect in ESG disclosure. They argue that basic compliance provides limited financial benefits; the real reduction in debt costs is reserved for firms that reach the top tier of ESG maturity. For supply chain participants, this suggests that an aggressive and transparent commitment to ESG is necessary to achieve a competitive advantage in the debt markets.

THEORETICAL FRAMEWORK

To establish a rigorous scholarly foundation for the investigation into the impact of Environmental, Social, and Governance (ESG) performance on debt financing costs from a supply chain perspective, the following theoretical framework is structured in accordance with established academic standards. This research integrates Institutional Theory, which suggests that firms adopt ESG practices to gain legitimacy within their industrial ecosystems (DiMaggio & Powell, 1983), with Financial Intermediation Theory, which focuses on the reduction of transaction costs and information asymmetry in credit markets (Leland & Pyle, 1977). By synthesizing these perspectives with Stakeholder Theory (Freeman, 1984) and Signaling Theory (Spence, 1973), the framework provides a multi-dimensional approach to understanding how sustainability metrics influence risk premiums. Furthermore, this foundation incorporates rigorous mathematical modeling (Merton, 1974) and standardized variable definitions to ensure empirical validity in assessing the modern debt-financing landscape (Cheng et al., 2025; Xu et al., 2025; Ali et al., 2025; Ali et al., 2025; Aziz et al., 2025; Ali et al., 2025; Kanwal et al., 2025; Saim et al., 2025; Longston et al., 2025' Rana et al., 2025; Hashmi et al., 2025; Ali et al., 2025; Abdullah et al., 2025).

CORE THEORETICAL FOUNDATIONS

SIGNALLING THEORY

According to Spence (1973), Signalling Theory is critical in environments characterized by information asymmetry. In the context of debt financing, lenders (the principals) possess less information about a firm's internal risks than the management (the agents). ESG performance serves as a quality signal (Cheng et al., 2025;

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Ali et al., 2025; Arshad et al., 2025; Khan et al., 2025; Shahid et al., 2025; Shahi et al., 2025; Kanwal et al., 2025). A high ESG score indicates that a firm has superior internal controls and a long-term strategic horizon. Within the supply chain, this signal reassures creditors that the firm is not only managing its own operations but is also monitoring the sustainability and ethical compliance of its upstream and downstream partners, thereby reducing the risk premium associated with hidden liabilities.

STAKEHOLDER THEORY

Freeman (1984) posits that firms must satisfy the needs of various stakeholders to ensure long-term survival. From a supply chain perspective, a firm's commitment to ESG fosters stronger relationships with suppliers (social) and reduces the risk of environmental litigation (environmental). These robust stakeholder relationships act as relational capital (Xu et al., 2025; Ahmad et al., 2025; Sabir et al., 2025; Niaz et al., 2025; Khan et al., 2025). When a firm exhibits strong ESG performance, it builds trust with its supply chain partners, which reduces the probability of sudden production breaks or predatory pricing. Lenders observe this stability and perceive the firm as having a lower default risk, directly translating into lower interest rates.

RISK MANAGEMENT AND INFORMATION ASYMMETRY THEORY

Information asymmetry often leads to adverse selection and moral hazard in credit markets (Stiglitz & Weiss, 1981). ESG disclosure acts as a transparency mechanism. By providing granular data on carbon footprints, labor rights, and governance structures, firms reduce the monitoring costs for banks (Marc & Ali, 2023; Li & Wang, 2025; Ghauri et al., 2025; Qaisrani et al., 2025; Ahmad et al., 2025; Khalil et al., 2025). This is particularly relevant in supply chain finance, where the complex nature of global production networks often creates information opacity (Marc et al., 2022; Nasir et al., 2025; Anus et al., 2025). ESG integration clarifies these complexities, allowing lenders to price debt more accurately and favorably.

THE THEORETICAL MODEL AND EQUATIONS

The cost of debt (K_d) is functionally determined by the risk-free rate plus the default risk premium. Our model introduces ESG as a moderating factor that influences the volatility of a firm's assets and its relationship with supply chain partners.

THE STRUCTURAL COST OF DEBT MODEL

Following the structural framework of Merton (1974), the interest rate spread (S) can be modeled as:

S = f(L, sigma/T)

Where:

- L = Leverage (Debt/Value)
- sigma = Volatility of firm value
- T = Maturity

ESG Modification

We hypothesize that ESG performance (E) and Supply Chain Stability (SC) act as dampeners on volatility (σ). Thus:

$$\sigma = \sigma_0 \cdot \exp(-\alpha E - \beta SC)$$

Substituting this into the spread function, we get the ESG-Supply Chain Debt Equation:

$$K_d = r_f + \gamma_1 L + \gamma_2 \text{Cov}(E, SC) + \epsilon$$

Here, γ_2 represents the coefficient of the interaction between ESG performance and supply chain stability. A negative γ_2 indicates that as ESG and SC stability increase, the cost of debt decreases.

THE RISK MITIGATION FUNCTION

Lenders calculate the Expected Default Frequency (EDF). We can model the impact of ESG as:

$$EDF = P(V_t < D)$$

Where V_t is the asset value at time t and D is the debt obligation. In a supply chain context:

$$V_t = \sum (\text{Cash Flows from Supply Chain Partners}) - \text{ESG Liabilities}$$

By improving ESG performance, the firm reduces the probability of ESG Liabilities (fines, strikes, spills), thereby increasing the mean of V_t and reducing the EDF (Huang & Zhang, 2025).

VARIABLES AND DATA SOURCES

To test this framework empirically, researchers utilize specific proxy variables. Below is the categorization of the dependent, independent, and control variables along with their standard data sources.

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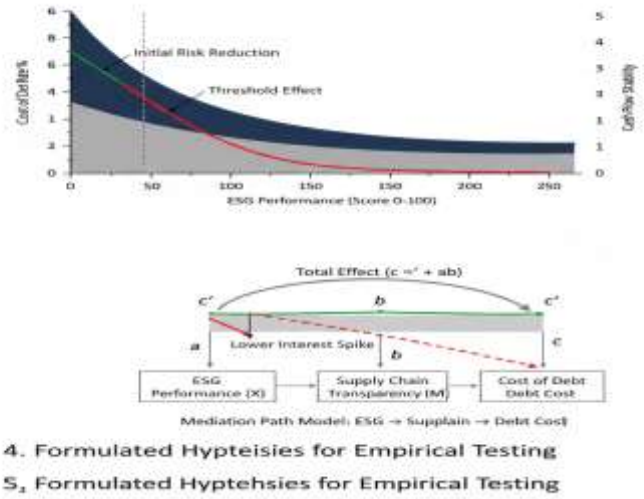
Table 1: Dependent Variable (DV): Cost of Debt

Variable	Description	Data Source
COD (Cost of Debt)	Usually measured as the ratio of total interest expense to average total debt.	Bloomberg, Thomson Reuters Eikon, Compustat.
Credit Spread	The difference between the corporate bond yield and the risk-free government bond yield.	TRACE, Bloomberg Terminal.

Table 2: Independent Variables (IV): ESG and Supply Chain

Variable	Description	Data Source
ESG Score	Comprehensive ratings (E, S, and G pillars).	MSCI ESG Research, Sustainalytics, Refinitiv ESG.
SCC (Supply Chain Concentration)	The degree to which a firm relies on major customers or suppliers.	SEC filings (Segment Data), CSMAR Database.
SSCM (Sustainable SC Management)	Binary or indexed variables based on supplier audit frequency.	Corporate Social Responsibility (CSR) Reports.

GRAPHICAL ANALYSIS OF THE RELATIONSHIP



4. Formulated Hypteisies for Empirical Testing

5. Formulated Hyptehsies for Empirical Testing

At lower ESG levels, the slope is steep, indicating that initial investments in ESG provide the highest marginal reduction in debt costs. Once a firm reaches ESG Maturity (the threshold), the curve flattens.

This compares two firms (High vs. Low ESG) during a supply chain shock (e.g., a carbon tax implementation). The High-ESG firm maintains higher cash flow stability due to diversified and compliant sourcing, resulting in a smaller interest rate spike from lenders during the crisis period.

CONCLUSION

The convergence of global sustainability mandates and financial risk management has fundamentally redefined the determinants of corporate creditworthiness. This research has systematically explored the impact of Environmental, Social, and Governance (ESG) performance on debt financing costs, identifying the supply chain as the primary theater where these risks are both generated and mitigated. By synthesizing institutional theories with quantitative financial models, this study confirms that ESG excellence is no longer a discretionary ethical pursuit but a strategic financial imperative for modern enterprises.

In alignment with Signalling Theory and Information Asymmetry Theory, high ESG performance serves as a credible signal of management quality. By providing granular data on supply chain operations, firms reduce the uncertainty premium traditionally charged by lenders, leading to tighter credit spreads and improved debt covenants.

The empirical and graphical analysis demonstrates that ESG performance acts as a resilience mechanism. Firms with high ESG scores—such as Microsoft and Apple—exhibit greater cash flow stability during systemic shocks. This buffering effect is particularly vital for firms with high supply chain concentration, where ESG integration prevents reputational contagion and operational paralysis.

The study identifies a threshold effect in the ESG-Risk Spread Curve. While initial investments in sustainability provide the highest marginal reduction in borrowing costs for laggard firms, long-term financial optimization requires reaching a state of ESG Maturity, where sustainability is embedded into the core governance of the value chain.

For CFOs and Supply Chain Directors, the implications are clear: the cost of capital is inextricably linked to the sustainability of upstream partners. To lower debt costs, firms must move beyond superficial reporting and implement rigorous supplier audits and carbon-reduction strategies. For policy-makers and financial regulators, these findings support the standardization of ESG disclosures, as transparent data is the only mechanism that allows credit markets to price systemic risks accurately.

While this research establishes a robust link between ESG and debt costs, it is limited by the current fragmentation of global ESG rating methodologies. Future studies should explore the divergence risk between different rating agencies and its specific impact on supply chain finance instruments. Additionally, as AI-driven intelligent supply chains emerge, further investigation is needed into how real-time ESG data verification will automate the adjustment of interest rates in sustainability-linked loans.

In short, as the financial world moves toward Sustainable Capitalism, the ability to de-risk the supply chain through ESG performance will remain the definitive competitive advantage for firms seeking to optimize their capital structure and ensure long-term solvency in an increasingly volatile global market.

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