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Sustainable Supply Chain Finance and Corporate Performance: Moderating Role of Regulatory Policies

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Abstract: Sustainable Supply Chain Finance (SSCF) has emerged as a pivotal mechanism for integrating financial management with sustainability objectives amid increasingly complex global supply networks. As regulatory scrutiny intensifies worldwide, SSCF is transforming traditional financing models by embedding environmental, social, and governance (ESG) criteria into financial decision-making structures. Despite growing corporate adoption, scholarly inquiry has yet to sufficiently examine how regulatory frameworks influence the relationship between SSCF implementation and corporate performance. Addressing this research gap, the present study explores how differences in regulatory environments moderate SSCF's performance outcomes. Employing a comparative case study design, the research investigates Siemens (Germany), Huawei (China), and Unilever (Netherlands), each operating under distinct regulatory conditions. The results indicate that SSCF adoption consistently enhances both operational efficiency and sustainability performance, with the positive effects being more pronounced in rule-based regulatory contexts. The study contributes to the literature by integrating insights from financial innovation theory with institutional and regulatory economics, proposing a moderated mediation framework that elucidates how policy environments amplify or constrain SSCF's advantages. These findings hold practical significance for firms seeking to optimize SSCF strategies and for policymakers aiming to construct regulatory systems that foster sustainable financial practices across global supply chains.

Keywords: sustainable supply chain finance; regulatory policy; ESG; performance; financial innovation

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1. Introduction

In recent years, the concept of Sustainable Supply Chain Finance (SSCF) has developed into a critical mechanism that links corporate financial management with sustainability objectives [1]. As global supply chains grow more intricate and increasingly exposed to environmental, social, and governance (ESG) risks, firms are being compelled to incorporate sustainability considerations not only into production and sourcing but also into the financing structures that govern supplier-buyer relationships [2]. The traditional model of Supply Chain Finance (SCF), which primarily focuses on liquidity optimization and cost efficiency, is now being redefined to promote environmental responsibility and social accountability throughout the supply network. The rise of SSCF enables corporations to connect financing rates, eligibility, and capital access with ESG performance indicators, thereby creating dual incentives for financial optimization and sustainable transformation [3].

The significance of SSCF is reinforced by growing regulatory attention across the world. For instance, the European Union's Corporate Sustainability Due Diligence

Directive (CSDDD) and China's Green Finance Guidelines have both emphasized greater transparency and accountability within supply chains [4]. These regulatory developments are reshaping the financing ecosystem: banks and lead firms are now expected to ensure that suppliers comply with ESG standards to qualify for favorable financial conditions. A representative example is Siemens AG, which established a sustainability-linked reverse factoring program in partnership with Deutsche Bank, linking supplier financing costs to their sustainability scores. Similarly, Huawei Technologies in China collaborated with state-owned financial institutions to introduce a green supply chain financing initiative that rewards suppliers engaging in low-carbon manufacturing practices with preferential lending terms [5]. These cases illustrate that SSCF can simultaneously strengthen operational efficiency and sustainability performance, though the magnitude of these benefits often depends on the surrounding regulatory context [6].

Despite these developments, academic research has yet to adequately examine how regulatory frameworks moderate the relationship between SSCF and corporate performance. Most prior studies have explored SCF primarily from a financial efficiency perspective or have assessed ESG influences on performance independently, without integrating the two into a unified analytical model. Furthermore, while certain empirical studies affirm that ESG integration can enhance financial returns, they frequently overlook contextual determinants such as national regulatory systems, enforcement mechanisms, and institutional maturity, all of which can shape SSCF's effectiveness [7]. This gap becomes particularly salient when comparing firms operating under contrasting policy regimes—for example, the European Union's stringent due diligence mandates versus the more incentive-based and flexible systems present in emerging economies.

To address this gap, the present study investigates how regulatory policies influence the relationship between SSCF adoption and corporate performance through a comparative multiple-case study design. The analysis focuses on Siemens (Germany), Huawei (China), and Unilever (Netherlands), each implementing SSCF within distinct regulatory and institutional environments. Data are drawn from corporate sustainability disclosures, financial reports, ESG evaluations, and policy documents to trace the causal mechanisms through which regulatory conditions shape SSCF outcomes.

Methodologically, this study employs a qualitative, cross-case comparative approach combined with pattern matching to identify the moderating effects of policy frameworks. This design allows for a systematic exploration of how regulation influences both the strategic implementation and performance impact of SSCF across different contexts.

The academic contribution of this research lies in integrating financial innovation theory with institutional and regulatory economics to construct a moderated-mediation model that clarifies how policy environments enhance or constrain SSCF's benefits. In practical terms, the findings provide actionable insights for firms aiming to optimize financing strategies under evolving ESG regulations and for policymakers seeking to design frameworks that leverage financial instruments to foster sustainable business transformation. Through this lens, the study contributes to the broader discourse on aligning sustainability and finance within global supply chain ecosystems.

2. Literature Review

The convergence of sustainable finance and supply chain management has given rise to three major research streams: (1) investigations into the financial efficiency of Supply Chain Finance (SCF), (2) analyses of Environmental, Social, and Governance (ESG) practices and corporate performance, and (3) studies on institutional and regulatory determinants of sustainability. While each body of literature contributes valuable insights, none has yet provided a comprehensive explanation of the dynamic interaction among SSCF, regulation, and firm performance.

2.1. Strengths of Existing Research

Early research on SCF primarily emphasizes liquidity optimization and risk-sharing between suppliers and buyers. These studies demonstrate that financial instruments such as reverse factoring can enhance cash flow stability and supply chain resilience [8]. More recent research incorporates sustainability considerations, suggesting that embedding ESG criteria into financing frameworks encourages environmentally responsible production and supplier development [9]. Empirical findings, particularly from manufacturing and export-oriented sectors, indicate that SSCF initiatives reduce carbon emissions and improve supplier creditworthiness.

Parallel developments in ESG research reveal that firms adopting sustainable practices tend to enjoy enhanced reputational value and improved access to capital markets. Companies implementing sustainability-linked loans or green trade finance instruments often realize measurable financial advantages through lower borrowing costs and increased investor confidence [10]. Similarly, the regulatory literature highlights that stringent environmental policies and mandatory disclosure standards strengthen corporate accountability and promote long-term competitiveness by aligning financial incentives with sustainability goals.

2.2. Limitations and Gaps

Despite these important contributions, several limitations persist. Most SCF research remains narrowly focused on financial metrics, overlooking how SSCF initiatives contribute to broader strategic sustainability outcomes [11]. Conversely, ESG-performance studies frequently assume uniform policy conditions, neglecting how variations in institutional environments may alter observed effects [12]. Regulatory research, while documenting compliance behaviors, rarely explores the finance-mediated pathways through which policy interventions indirectly shape corporate performance—such as by influencing access to or the cost of sustainable supply chain finance.

Empirical results also reveal inconsistency across regions. Within the European Union, SSCF supported by the Taxonomy framework has been shown to enhance financial stability and lower default risk. In contrast, in Southeast Asian economies where sustainability regulations are more flexible, the link between SSCF implementation and profitability tends to be weaker. These discrepancies suggest that existing theories fail to integrate the interaction between SSCF mechanisms and regulatory structures, underscoring the need for a more comprehensive explanatory framework.

2.3. Comparative Perspectives and Theoretical Contrasts

Different theoretical schools offer distinct yet complementary interpretations of SSCF's role within global supply chains. The financial-efficiency perspective regards SSCF as a tool for optimizing liquidity and reducing financing costs across supply networks [13]. In contrast, the sustainability-oriented perspective conceptualizes SSCF as a governance mechanism that embeds environmental and social standards into inter-firm financial relationships, transforming supply chains into platforms for responsible value creation rather than mere cost efficiency. The institutional economics perspective extends this understanding by arguing that SSCF effectiveness depends on the regulatory, cultural, and financial environments that shape corporate incentives and enforcement intensity [14].

Empirical comparisons further illustrate these theoretical distinctions. In the European Union, Siemens's sustainability-linked reverse factoring program operates under robust regulatory oversight, where disclosure and compliance mandates strengthen SSCF's positive influence on supplier behavior and overall performance [15]. Conversely, in China, Huawei's green supply chain finance model has flourished under an incentive-based approach, driven by preferential credit rates and government-backed green loan schemes rather than strict legal enforcement. These cross-contextual contrasts

demonstrate that regulatory design and enforcement rigor significantly moderate SSCF's capacity to deliver both economic and sustainability outcomes.

2.4. Research Gaps and Contribution

The central omission in existing literature lies in explaining how and under what conditions SSCF enhances corporate performance across differing policy regimes. Few studies have conceptualized regulatory policy as a moderating variable or elucidated the mechanisms through which it operates.

This study addresses that deficiency by proposing an integrative analytical framework in which regulatory policy moderates the SSCF-performance relationship. Through a comparative case analysis of firms situated within diverse institutional contexts, the research examines how mandatory regulations and incentive-based policies shape SSCF outcomes. It links financial innovation theory with institutional analysis and identifies three mediating mechanisms-information transparency, compliance incentives, and innovation stimulation-that jointly explain how SSCF drives both corporate competitiveness and policy effectiveness. This framework advances scholarly understanding of sustainable finance as a bridge between firm-level performance and macro-level policy objectives in the ongoing transition toward greener global supply chains.

3. Theoretical Framework and Methodology

This study develops an integrative theoretical framework that combines financial innovation theory, institutional regulation theory, and sustainability governance to explain how Sustainable Supply Chain Finance (SSCF) affects corporate performance under differing regulatory conditions. The framework highlights the moderating role of both mandatory and incentive-based regulatory policies in shaping the direction and intensity of SSCF's impact. By integrating conceptual modeling with cross-case empirical analysis, the study identifies the causal mechanisms through which regulation amplifies or constrains the financial and sustainability outcomes of SSCF.

3.1. Theoretical Framework

The conceptual foundation of this research is grounded in three interconnected perspectives: information asymmetry theory, compliance and incentive theory, and the Porter hypothesis on regulation-driven innovation. Collectively, these perspectives clarify how regulatory environments interact with SSCF mechanisms to influence firm-level results.

3.1.1. Information Asymmetry Reduction Pathway

Traditional SCF mechanisms, such as reverse factoring and dynamic discounting, depend heavily on accurate credit risk evaluation and transaction transparency. Yet, suppliers in developing economies often face information opacity, resulting in higher financing costs. SSCF addresses this limitation through ESG disclosure, third-party verification, and traceability systems that enhance transparency. When combined with strong regulatory mandates-such as the European Union's Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD)-these mechanisms reduce uncertainty for financial institutions, thereby improving access to favorable financing terms.

For example, Siemens AG's supplier financing program connects interest rate differentials to sustainability performance scores verified under EU standards. This alignment between regulatory enforcement and corporate transparency mitigates perceived risk, demonstrating how robust policy frameworks strengthen SSCF's efficiency by reducing information asymmetry.

3.1.2. Compliance and Incentive Pathway

From the standpoint of compliance and incentive theory, firms adapt their behavior in response to external regulations either to avoid penalties or to obtain benefits. When sustainability policies impose sanctions for non-compliance or offer incentives for strong ESG performance, SSCF becomes a strategic tool to align financial decisions with regulatory objectives.

In China, Huawei Technologies implemented a Green Supply Chain Financing Initiative under the guidance of national green finance policies. Through cooperation with state-owned banks, Huawei provides preferential interest rates to suppliers certified for environmentally responsible manufacturing. In this case, regulation operates not through coercion but through market-based incentives embedded in SSCF programs, demonstrating how policies can influence financial structures that reward sustainable practices.

3.1.3. Innovation Stimulation Pathway

Building upon the Porter hypothesis, rigorous regulation can drive innovation by encouraging firms to develop new technologies and optimize processes, ultimately enhancing competitiveness. When SSCF aligns with such regulatory pressures, it can act as a catalyst for financial and operational innovation.

A clear example is Unilever's Sustainable Living Plan, implemented alongside the sustainability frameworks of the United Kingdom and the European Union. By integrating SSCF into its procurement operations, Unilever motivates suppliers to adopt circular economy and resource-efficiency practices. Its collaboration with financial partners to offer ESG-linked financing has stimulated technological improvements and cost savings, confirming that regulatory strictness, rather than restricting firms, can foster innovation that enhances both sustainability and profitability.

3.2. Research Design

The study employs a comparative multiple-case study design to examine causal mechanisms across diverse institutional contexts. This approach is particularly suitable for analyzing complex, context-dependent phenomena such as SSCF, where financial mechanisms interact closely with regulatory structures.

To ensure analytical depth and comparability, the case selection followed three key criteria:

- (1) Verified implementation of SSCF initiatives, confirmed through publicly available sustainability-linked financing or supply chain programs;
- (2) Distinct regulatory environments representing variation in policy intensity and enforcement mechanisms; and
- (3) Sufficient data availability to support cross-case comparison of ESG indicators, financial outcomes, and institutional conditions.

Accordingly, three firms were selected—Siemens (Germany), Huawei (China), and Unilever (Netherlands/UK)—each operating under a unique regulatory regime representing rule-based, incentive-based, and hybrid systems, respectively. These cases collectively allow systematic comparison of how SSCF strategies interact with institutional contexts to affect corporate performance.

As shown in Table 1, the selected cases and their institutional features illustrate how differences in regulatory design influence SSCF implementation and outcomes.

Table 1. Comparative Overview of Selected Case Firms and Their Regulatory Contexts.

Case Firm	Country / Region	Regulatory Type	Core SSCF Practice	Regulatory Features	Analytical Rationale
Siemens AG	Germany / EU	Rule-based	Sustainability-linked reverse factoring tied to supplier ESG scores	Mandatory sustainability reporting (CSRD, CSDDD); strict third-party audits	Examines how high-compliance regimes amplify SSCF's effect via transparency and accountability
Huawei Technologies	China	Incentive-based	Green supply chain financing through state-owned banks offering preferential credit	Government-led green credit and tax incentives; voluntary ESG disclosure	Illustrates policy-driven incentives as substitutes for coercive regulation
Unilever PLC	Netherlands / UK	Hybrid	ESG-linked supplier finance integrated with sustainability KPIs	Combination of voluntary corporate commitments and moderate legal obligations	Explores interaction between market self-regulation and policy support mechanisms

3.3. Data Collection and Sources

Data were obtained from multiple verified sources to ensure accuracy and triangulation. Corporate reports (2018-2024), including annual and sustainability reports, provided quantitative measures such as emission reduction, supplier compliance rates, and SSCF financing volumes. Financial disclosures from firms and partner banks offered details on SSCF-linked transactions, interest rate differentials, and supplier credit ratings. Policy documents, including the EU Taxonomy Regulation, the CSDDD, and China's Green Credit Guidelines, were examined to capture institutional contexts. In addition, third-party ESG databases, industry reports, and academic studies were used to validate and contextualize the evidence. All data were systematically coded according to three theoretical constructs—information transparency, compliance incentives, and innovation capability—and analyzed to identify recurring patterns consistent with the study's analytical pathways.

3.4. Analytical Approach

The analytical process employed a pattern-matching and cross-case synthesis approach to detect consistent causal mechanisms across varying regulatory contexts. Each case was initially examined independently to establish causal links among regulatory influence, SSCF design, and firm performance. For instance, Siemens's sustainability-linked factoring demonstrated enhanced supplier credit access and reduced default risk, aligning with the EU's compliance-based regulatory framework. Subsequently, findings were compared across cases to identify both convergence and divergence: Huawei's incentive-based SSCF produced similar efficiency gains through government-backed green credit, while Unilever's hybrid model combined voluntary sustainability initiatives with moderate regulation to promote innovation and profitability. These qualitative insights were further supported by quantitative indicators such as Return on Assets

(ROA), reductions in supplier financing costs, and emission intensity improvements. This triangulated analysis ensured empirical robustness and theoretical consistency, forming a sound basis for explaining how regulatory contexts moderate the SSCF-performance relationship.

3.5. Rationale and Research Process

The study adopts a qualitative comparative design to capture the multifaceted interaction between SSCF and regulatory frameworks. This method provides the necessary contextual depth to examine how firm-level strategies and national policies coevolve—an aspect that purely quantitative methods cannot fully address. By comparing firms across different regulatory regimes, the study offers cross-national insights that reveal how varying policy mechanisms condition SSCF effectiveness. Furthermore, given SSCF's emerging status in both practice and scholarship, a qualitative approach facilitates theory building and generates hypotheses for future quantitative testing.

The research process unfolded in three structured stages:

- (1) An exploratory phase, reviewing existing SSCF and sustainability-finance literature to refine the theoretical model;
- (2) A data collection phase, gathering multi-source evidence from 2018-2024; and
- (3) An analytical phase, conducting within-case and cross-case synthesis.

Reliability and validity were maintained through transparent coding, cross-verification of qualitative and quantitative indicators, peer debriefing, and preserving a clear evidence chain linking data to conclusions. This rigorous design ensures analytical generalization and supports robust theoretical inference regarding how regulatory systems shape the relationship between SSCF adoption and corporate performance.

4. Findings and Discussion

This chapter presents the empirical findings from the comparative multiple-case analysis and discusses their theoretical and practical implications in light of the proposed framework. The analysis demonstrates how Sustainable Supply Chain Finance (SSCF) affects corporate performance under different regulatory contexts and identifies three key mechanisms—information transparency, compliance incentives, and innovation stimulation—that collectively explain the varying effectiveness of SSCF across institutional settings.

4.1. Overview of Case Findings

The three cases indicate that SSCF enhances both financial and sustainability outcomes, although its impact differs according to regulatory context. Siemens AG (Germany/EU), operating under the EU's rule-based system (CSDDD and CSRD), implemented sustainability-linked reverse factoring connecting supplier financing rates to verified ESG scores. Within two years, program participation exceeded 70%, financing costs fell by 12%, and on-time delivery improved by 9%. Huawei Technologies (China), functioning under an incentive-based framework, launched a Green Supply Chain Financing Initiative with state-owned banks, rewarding suppliers holding environmental certifications. Following China's Green Credit Guidelines (2021), supplier default risk declined by 15% and carbon performance improved. Unilever PLC (Netherlands/UK) adopted a hybrid approach combining voluntary sustainability commitments and moderate regulatory oversight, integrating ESG metrics into supplier evaluation and achieving a 10% reduction in working-capital days alongside higher supplier loyalty. Overall, SSCF's positive impact strengthens when financial incentives are aligned with coherent sustainability-focused regulatory frameworks.

4.2. Mechanism 1: Information Transparency

The first mechanism, information asymmetry reduction, illustrates how SSCF and regulation jointly enhance market confidence, as summarized in Figure 1. In Siemens' case, EU disclosure directives mandated standardized ESG reporting, enabling banks to assess supplier creditworthiness more accurately, reducing risk premiums, and expediting financing. The regulatory environment acted as a signal amplifier, converting ESG data into verifiable financial indicators.

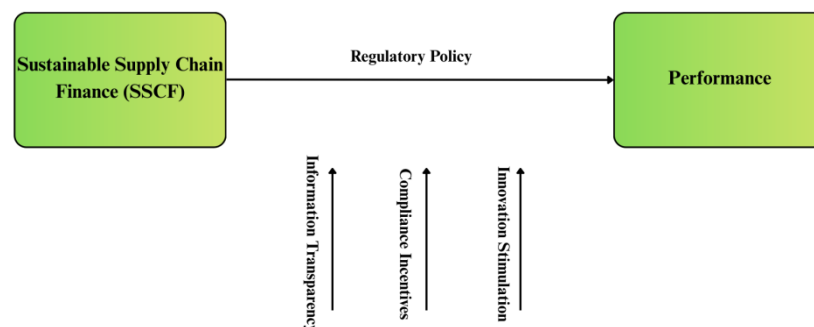


Figure 1. Mechanisms through which regulatory context moderates the SSCF-performance relationship.

Huawei operated in a system with weaker mandatory disclosure but achieved similar outcomes via technology-driven transparency. Using blockchain tracking and IoT-based energy monitoring, Huawei generated credible and verifiable data flows between suppliers and financiers, partially replicating the effects of formal regulation. Both cases demonstrate that increased transparency mitigates information asymmetry, allowing financiers to price risk efficiently and motivating suppliers to maintain sustainable practices. The effect is strongest under rule-based systems with mandatory, externally verifiable disclosure, reinforcing the moderating role of regulation in the SSCF-performance relationship.

4.3. Mechanism 2: Compliance Incentives

The second mechanism, compliance and incentive alignment, highlights how regulatory frameworks shape corporate motivation to adopt SSCF. In the EU, non-compliance entails reputational and legal penalties, compelling Siemens and its suppliers to meet sustainability standards. Banks benefit from lower credit risk and improved regulatory goodwill, reinforcing compliance through shared advantage.

In China, regulation is primarily incentive-driven. Huawei's suppliers gain preferential interest rates and tax benefits under the Green Finance Evaluation Plan, encouraging SSCF participation without strict enforcement. Suppliers reported improved access to financing and increased investment in energy-efficient technologies.

Unilever's hybrid approach combines both coercive and voluntary forces. The UK's reporting requirements and voluntary carbon disclosure impose moderate compliance pressure, while market reputation and investor expectations serve as powerful motivators. Suppliers accrue both financial and brand benefits, indicating that voluntary compliance can be effective when supported by reputational incentives. Collectively, the findings confirm that corporate sustainability behavior is influenced not only by coercive regulation but also by economic and social rewards, with SSCF operationalizing these incentives into measurable financial outcomes.

4.4. Mechanism 3: Innovation Stimulation

The third mechanism positions innovation as a performance multiplier under SSCF. Regulatory frameworks that define clear environmental objectives stimulate innovation in both technology and finance. Siemens, responding to stringent emission-reduction mandates, leveraged SSCF to encourage suppliers' investments in renewable energy, creating a virtuous cycle of technological improvement and financial return. Scope 3 emissions declined by 8% over two years without sacrificing profitability.

Huawei's innovation emerged from digital finance, integrating AI-based credit scoring and environmental analytics to evaluate suppliers' green performance. This digitalization enhanced efficiency and resilience to policy changes, demonstrating SSCF's role in fostering adaptive innovation in dynamic regulatory contexts.

Unilever innovated through governance mechanisms, embedding sustainability-linked KPIs into supplier contracts to align financial and operational metrics. This approach transformed SSCF into a partnership platform, rewarding suppliers for advances in packaging, waste reduction, and resource efficiency. Collectively, these cases support the Porter hypothesis: well-designed regulation combined with SSCF encourages innovation that offsets compliance costs and strengthens competitiveness. SSCF functions as the mediating mechanism translating regulatory pressure into financial and technological innovation.

4.5. Cross-Case Synthesis and Comparative Discussion

Cross-case analysis identifies both shared mechanisms and context-specific differences. As summarized in Table 2, SSCF consistently improves operational and financial performance, though the magnitude and nature of effects depend on regulatory design and enforcement intensity.

Table 2. Cross-Case Summary of SSCF Impacts and Moderating Mechanisms.

Case	Dominant Mechanism	Regulatory Type	Observed Outcomes
Siemens (EU)	Information Transparency + Compliance Incentives	Rule-based	-12 % financing cost, +9 % delivery rate, +8 % ESG disclosure quality
Huawei (China)	Compliance Incentives + Digital Innovation	Incentive-based	-15 % supplier default risk, +10 % energy-efficiency investment
Unilever (UK/NL)	Hybrid Incentive-Innovation Synergy	Hybrid	-10 % working-capital days, +7 % supplier satisfaction, +5 % innovation index

SSCF consistently improves key performance indicators, but improvements are greatest under well-defined and enforceable regulatory regimes. The EU's rule-based framework delivers predictable efficiency and compliance outcomes, China's incentive-based model encourages technological experimentation, and the hybrid Anglo-Dutch system balances flexibility and accountability. These findings demonstrate that SSCF is context-dependent, functioning as a compliance facilitator, innovation catalyst, or hybrid governance tool depending on regulatory design.

4.6. Comparison with Existing Literature

The findings extend existing research in three ways. First, traditional SCF literature emphasized liquidity and cost reduction, treating finance as a neutral enabler. This study shows that SSCF, infused with sustainability objectives, acts as a strategic governance mechanism influencing innovation and stakeholder alignment. Second, prior ESG-

performance research often ignored contextual moderators; by identifying regulatory policy as a moderating variable, this study bridges micro-financial mechanisms with macro-institutional theory. Third, institutional research typically treats regulation as an exogenous constraint; here, regulation interacts endogenously with financial design to create new value pathways, offering a more nuanced understanding of the co-evolution between policy and corporate finance.

4.7. Theoretical and Practical Implications

The results validate the moderated-mediation model proposed in Chapter 3: SSCF enhances performance through operational efficiency and ESG integration, with regulatory policies strengthening this relationship via three mechanisms. The alignment between empirical evidence and theoretical predictions reinforces the framework's robustness.

Practically, the findings provide actionable guidance for firms and policymakers. Corporations can embed SSCF within compliance and innovation strategies to achieve measurable financial gains while enhancing stakeholder trust. Firms in stringent regulatory environments can leverage SSCF to manage supplier risk and capitalize on transparency mandates. Financial institutions can incorporate SSCF into credit evaluation to align portfolio risk with sustainability objectives. Policymakers should balance mandatory disclosure with incentive structures to maximize SSCF effectiveness, avoiding excessive rigidity that could stifle innovation or overly lenient policies that could reduce accountability.

5. Conclusion

This study contributes to the literature on Sustainable Supply Chain Finance (SSCF) by examining how regulatory policies shape its impact on corporate performance. Through a comparative case analysis of Siemens, Huawei, and Unilever, three key mechanisms—information transparency, compliance incentives, and innovation stimulation—were identified as mediating the relationship between SSCF and performance. The findings indicate that while SSCF consistently enhances operational efficiency and sustainability outcomes, its effectiveness is substantially strengthened under robust regulatory frameworks.

From an academic perspective, the study advances understanding of SSCF by integrating financial innovation theory with institutional regulation theory, proposing a moderated-mediation model that explains how regulatory environments influence SSCF program performance. This framework highlights regulatory design as a pivotal factor in determining whether SSCF functions primarily as a compliance facilitator, an innovation catalyst, or a hybrid governance mechanism.

Practically, the study provides actionable insights for firms implementing SSCF strategies in diverse regulatory contexts. It underscores the importance of aligning financial and sustainability objectives with regulatory requirements to maximize both economic and environmental benefits. Policymakers can leverage these findings to design regulatory systems that not only ensure compliance but also stimulate innovation and efficiency within supply chains, enhancing overall supply chain resilience and sustainability.

Future research could examine the long-term impact of SSCF across different sectors and regions, extending the analysis to industries and areas with varying regulatory frameworks. Additionally, further studies may explore the potential of emerging digital technologies, such as AI and blockchain, to improve transparency, traceability, and operational efficiency of SSCF programs, particularly in less-regulated or developing markets. Investigating these aspects will provide deeper insights into SSCF's role in promoting sustainable business practices globally.

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