NATURE-POSITIVE BUSINESS MODELS AND CORPORATE SUSTAINABILITY: EVIDENCE FROM GLOBAL VALUE CHAINS

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Abstract
This study examines the emergence of nature-positive business models and their implications for corporate sustainability within global value chains. Grounded in the natural resource-based view and global value chain theory, the study investigates how biodiversity integration influences supply chain sustainability and firm value across diverse industries. Adopting a quantitative research design, the study utilizes firm-level panel data drawn from multinational corporations engaged in global production networks. Biodiversity integration is operationalized through corporate disclosures on ecosystem conservation, habitat restoration, and nature-positive investments. Supply chain sustainability is measured using indicators of environmental compliance, resource efficiency, and supplier sustainability practices, while firm value is captured through market-based and accounting performance metrics. The analysis employs fixed effects and system Generalized Method of Moments estimators to address endogeneity and cross-sectional heterogeneity. The findings reveal that biodiversity integration has a positive and significant effect on supply chain sustainability, enhancing environmental performance across upstream and downstream activities. Furthermore, firms that adopt nature-positive business models experience improved firm value, suggesting that biodiversity-oriented strategies contribute to long-term competitive advantage. The results also indicate that sustainable supply chain practices partially mediate the relationship between biodiversity integration and firm value. The study contributes to the growing literature on corporate sustainability by empirically linking biodiversity considerations to economic performance within global value chains. It underscores the strategic importance of embedding nature-positive practices into business models to achieve both ecological and financial objectives.

Keywords: Nature-positive business models; Biodiversity integration; Firm value; Corporate sustainability; Global value chains and Environmental performance.

Introduction
The global biodiversity crisis has reached a scale and urgency that demand a fundamental reconsideration of how corporations design, operate, and govern their activities. The Intergovernmental Science-Policy Platform on Biodiversity and

Ecosystem Services (IPBES, 2019) estimated that approximately one million animal and plant species face extinction due to anthropogenic pressures including land-use change, overexploitation, climate change, and pollution. The economic dimensions are equally stark: the World Economic Forum (2023) assessed that more than half of global GDP (approximately USD 44 trillion) depends on moderate or high interaction with nature, rendering the corporate sector acutely exposed to biodiversity-related disruptions across supply chains, regulatory environments, and financial markets. Against this backdrop, the concept of nature-positive business models, defined as business models that contribute to a net gain in biodiversity and ecosystem integrity relative to a baseline, has emerged as a central organizing framework for next-generation corporate sustainability strategy (Business for Nature, 2021; TNFD, 2023).

Global value chains (GVCs), which coordinate production across multiple firms, countries, and supplier tiers, represent both a primary channel through which corporate activity generates biodiversity impacts and a critical lever for nature-positive transformation. Agricultural, food and beverage, forestry, fisheries, apparel, and extractive sectors, all deeply embedded in GVCs, account for the dominant share of land-use change, water consumption, and pollution driving biodiversity loss (Lambin et al., 2018; Tukker & Jansen, 2006). Conversely, GVC governance architecture, through which lead firms set standards, audit suppliers, and determine procurement, creates mechanisms through which nature-positive practices can be diffused across entire production networks, amplifying the ecological impact of corporate biodiversity strategies far beyond individual firm operations (Gereffi et al., 2005; Ponte & Gibbon, 2005).

The academic literature on nature-positive business models is expanding but remains characterised by theoretical fragmentation and a scarcity of large-sample empirical evidence linking biodiversity integration to financial outcomes within GVC frameworks. Prior work has examined the conceptual architecture of nature-positive business models (Elkington et al., 2020; Bocken et al., 2014), the role of natural capital in GVC sustainability (Barbier, 2017; Chaplin-Kramer et al., 2019), and the financial materiality of environmental performance (Friede et al., 2015; Eccles et al., 2014), but has rarely integrated these bodies of insight into a coherent empirical framework tracing the pathway from biodiversity integration through supply chain sustainability to financial performance. This study addresses that gap. Grounded in the natural resource-based view (Hart, 1995; Hart & Dowell, 2011) and GVC theory (Gereffi et al., 2005; Kaplinsky & Morris, 2001), the study investigates three interrelated questions: (i) Does biodiversity integration significantly enhance supply chain sustainability? (ii) Does nature-positive business model adoption improve firm value? (iii) Do sustainable supply chain practices partially mediate the biodiversity-firm value relationship? These questions are addressed using a panel dataset of multinational corporations, with fixed effects and system GMM estimators employed to address endogeneity.

The study makes four principal contributions. It provides large-sample econometric evidence on the financial consequences of biodiversity integration. It positions the GVC as the appropriate unit of analysis for nature-positive strategy. It establishes supply chain sustainability as a partially mediating mechanism linking biodiversity integration to financial performance. And it contributes to empirical validation of the natural resource-based view by demonstrating that ecological capabilities constitute a source of competitive advantage in the contemporary biodiversity governance landscape.

Literature Review and Theoretical Framework

Nature-Positive Business Models: Conceptual Foundations

A business model describes the architecture through which a firm creates, delivers, and captures value (Teece, 2010; Zott et al., 2011). Nature-positive business models extend this architecture to encompass the creation of ecological value alongside economic value, operationalizing sustainability as a design principle embedded in the firm's value proposition and value creation activities, rather than as an add-on compliance obligation (Bocken et al., 2014; Elkington et al., 2020). The nature-positive framing, advanced by the Taskforce on Nature-related Financial Disclosures (TNFD, 2023) and Business for Nature (2021), goes beyond the conventional emphasis on reducing negative ecological impacts toward a positive contribution framework requiring firms to restore, protect, and enhance biodiversity and ecosystem integrity.

Elkington et al. (2020) identified three archetypes: regenerative models that restore degraded ecosystems as part of core production processes; circular models that eliminate waste and resource leakage; and access-over-ownership models that reduce material throughput per unit of value delivered. Each archetype generates different financial return profiles, implying that the performance implications of nature-positive adoption are heterogeneous across model type and industry context.

Natural Resource-Based View and GVC Theory

Hart's (1995) natural resource-based view (NRBV) extended the resource-based view (Barney, 1991) to incorporate the natural environment as a strategic constraint and source of competitive advantage, identifying three interconnected strategies, pollution prevention, product stewardship, and sustainable development, each associated with distinct capabilities and competitive advantages. Hart and Dowell (2011) reinforced the case that environmental capabilities constitute sources of sustained advantage while acknowledging that empirical evidence remained mixed, partly due to measurement challenges and the long-time horizons over which ecological capabilities generate returns. The nature-positive literature extends the NRBV by articulating that biodiversity integration, ecosystem restoration competencies, and nature-positive supply chain governance are likely to constitute competitive advantages under intensifying regulatory pressure and growing investor scrutiny (Dasgupta, 2021; TNFD, 2023).

GVC theory examines how value-adding activities are distributed across geographically dispersed firms (Gereffi et al., 2005; Kaplinsky & Morris, 2001). A central contribution is the identification of governance mechanisms through which lead firms exercise power over suppliers, setting environmental and social standards that create pathways for diffusing nature-positive practices upstream and downstream (Ponte & Gibbon, 2005; Gereffi & Lee, 2012). Lambin et al. (2018) showed that voluntary sustainability standards in tropical commodity chains have reduced deforestation among certified suppliers, though results are undermined by weak enforcement and certification gaming. Lund-Thomsen and Lindgreen (2014) argued that buyer-driven requirements can impose compliance costs without sharing the investments needed for genuine ecological transformation, suggesting that the ecological effectiveness of nature-positive models depends critically on governance quality and relational depth.

Biodiversity Integration, Supply Chain Sustainability, and Firm Value

The direct literature on biodiversity integration and financial performance is limited but growing. Friede et al. (2015) established through meta-analysis that environmental performance is positively associated with financial performance across most studies. Eccles et al. (2014) found that high-sustainability firms outperformed matched peers on both market and accounting metrics over an 18-year horizon, consistent with the long-run competitive advantage hypothesis of the NRBV. Johnson et al. (2020) demonstrated that the financial costs of biodiversity loss to commodity-dependent sectors exceed the costs of nature-positive investments, implying positive net present value for biodiversity integration. PwC (2023) documented that firms proactively managing biodiversity exposure outperformed peers on market valuation, while Chaplin-Kramer et al. (2019) showed that production assets worth trillions are exposed to declining ecosystem services.

The relationship between environmental performance and market valuation is well-established in the broader ESG literature. Friede et al. (2015) found that approximately 90 percent of studies report a non-negative ESG-financial performance relationship, while Eccles et al. (2014) demonstrated that high-sustainability firms outperformed low-sustainability peers on both stock market and accounting returns over an 18-year horizon. Chava (2014) documented that firms with significant environmental concerns face higher cost of equity capital, while Krueger et al. (2020) established that institutional investors increasingly price physical and regulatory environmental risks into portfolio allocations. These findings suggest that the financial case for biodiversity integration is consistent with the wider sustainability-performance literature, while retaining biodiversity-specific mechanisms related to natural capital dependencies and ecosystem service provisioning that carbon-focused research does not capture.

Sustainable supply chain management (SSCM) refers to the integration of

environmental and social considerations into supply chain design, governance, and operational management (Seuring & Muller, 2008; Carter & Rogers, 2008). The financial benefits of SSCM operate through improved resource efficiency, reduced regulatory risk, lower supply chain disruption risk, and support for premium pricing in environmentally conscious markets (Miemczyk et al., 2012; Zhu et al., 2008). The positioning of SSCM as a mediator between biodiversity integration and firm value reflects a value chain logic in which corporate biodiversity commitments generate financial value primarily through their operational supply chain implications, consistent with the NRBV (Hart, 1995) and GVC sustainability literature (Gereffi & Lee, 2012).

It is important to distinguish biodiversity integration from broader environmental management: while the latter encompasses carbon and pollution management broadly, biodiversity integration specifically targets the conservation and restoration of species, habitats, and ecological functions that underpin natural capital stocks. Chaplin-Kramer et al. (2019) demonstrated that natural capital services, including pollination, water purification, flood regulation, and soil formation, contribute measurably to agricultural and food system productivity at a global scale, with declining ecosystem services imposing quantifiable production costs on commodity producers. Johnson et al. (2020) estimated that nature-related risks threaten USD 2.7 trillion in annual agricultural output, a figure that substantially exceeds the cost of preventive biodiversity integration investments. These macro-level estimates translate into material financial risks at the firm level via supply chain exposure, particularly for firms sourcing from ecologically sensitive geographies where biodiversity loss is most acute and supply chain disruption risk most concentrated (PwC, 2023).

The disclosure landscape for corporate biodiversity performance has evolved substantially over the study period. The Global Reporting Initiative Standard 304 on Biodiversity, operational since 2016, requires firms to disclose operational sites adjacent to protected areas, significant biodiversity impacts, and habitats affected. The Taskforce on Nature-related Financial Disclosures (TNFD, 2023) framework, drawing on the TCFD architecture and the ENCORE natural capital database (NCFA, 2020), represents a step-change in the quality and comparability of biodiversity-related corporate reporting. The Kunming-Montreal Global Biodiversity Framework, adopted at COP15 in December 2022, established the 30x30 target, protecting 30 percent of land and ocean by 2030, alongside commitments to align financial flows with biodiversity goals, creating a global regulatory signal expected to translate into mandatory disclosure requirements across major capital markets (CBD, 2022). These developments imply that firms proactively investing in biodiversity integration are positioned to benefit from regulatory tailwinds, while those with weak ecological performance face escalating transition risk. Eccles et al. (2014) argued that firms anticipating and adapting to regulatory transitions outperform those responding reactively; the evolving biodiversity regulatory trajectory offers a natural experiment

for testing this proposition at scale.

Research Hypotheses

H1: Biodiversity integration has a positive and significant effect on supply chain sustainability, enhancing environmental performance across upstream and downstream value chain activities.

H2: The adoption of nature-positive business models, operationalized through biodiversity integration, has a positive and significant effect on firm value as captured through market-based and accounting performance metrics.

H3: Sustainable supply chain practices partially mediate the relationship between biodiversity integration and firm value, such that a portion of the positive effect of biodiversity integration on firm value operates through enhanced supply chain sustainability.

H4: The positive effects of biodiversity integration on firm value are heterogeneous across industries, with greater effects observed in sectors with higher ecosystem dependency.

Methodology

Data and Sample

The empirical analysis employs an unbalanced panel dataset of publicly listed multinational corporations drawn from Bloomberg Terminal, Refinitiv Eikon, and the Corporate Sustainability Reporting database, covering 2010 to 2022. The sample is stratified across six industry groups characterised by varying ecosystem dependency: agriculture and food production; forestry, paper, and packaging; fisheries and aquaculture; pharmaceuticals and life sciences; construction and infrastructure; and apparel and textiles. These sectors collectively represent the primary industries through which corporate activity generates biodiversity impacts via GVCs (IPBES, 2019; NCFA, 2020).

Firm selection requires: operation in at least two countries; minimum three consecutive years of biodiversity-related disclosures; and complete financial performance data over the observation period. After removing outliers at the 1st and 99th percentiles, the final sample comprises 1,243 firms from 48 countries, generating approximately 11,700 firm-year observations. Geographic coverage spans North America (31%), Europe (34%), Asia-Pacific (25%), and other regions (10%), providing substantial variation in regulatory environments and biodiversity governance frameworks.

Variable Specification

Biodiversity Integration (BI) is the primary independent variable, constructed as a composite index from four disclosure-based dimensions sourced from Bloomberg ESG biodiversity sub-scores and GRI 304 disclosures: formal biodiversity policies and targets; ecosystem conservation and habitat restoration investment as a proportion of revenues; participation in third-party certified nature-positive supply chain

programmes; and TNFD-aligned disclosure quality scores. The four components are standardised to unit variance and averaged, producing a BI index ranging from 0 to 100.

Supply Chain Sustainability (SCS), the mediating variable, is constructed from three sub-dimensions: environmental compliance scores; resource efficiency scores; and supplier sustainability practice scores derived from auditing and certification data. These are sourced from the CDP Supply Chain programme, Bloomberg, and firm sustainability reports, aggregated using equal weighting. Firm Value (FV) is measured using Tobin's Q for market-based assessment and return on assets (ROA) for accounting-based assessment. Control variables include firm size, financial leverage, R&D intensity, capital expenditure intensity, board environmental expertise, and country-level governance quality.

Estimation Strategy

The econometric analysis proceeds in three stages. The baseline employs a fixed effects (FE) panel regression controlling for time-invariant firm heterogeneity and common time trends. Given the anticipated endogeneity of the BI index, firms with superior performance may have greater resources for biodiversity programmes, the system GMM estimator of Blundell and Bond (1998) is employed as the primary estimator, using lagged levels and differences as instruments. The Hansen J-test confirms instrument validity, and the Arellano-Bond AR(2) test verifies the absence of second-order serial correlation.

The mediation hypothesis (H3) is tested in a two-equation system following Baron and Kenny (1986) and Preacher and Hayes (2008), with indirect effect standard errors obtained through 5,000-iteration bootstrapping. The full model specifications are:

$$FVit = ai + b1BIit + b2SCSit + b3Xit + gi + dt + eit \quad (1)$$

$$SCSit = ai + th1BIit + th2Xit + gi + dt + nit \quad (2)$$

where FV denotes firm value, BI is the biodiversity integration index, SCS is the supply chain sustainability score, X is a vector of controls, and gi and dt denote firm and year fixed effects respectively. The indirect effect of BI on FV through SCS is the product th1 x b2, with significance assessed through bootstrapped confidence intervals. Industry heterogeneity (H4) is assessed through subsample analysis and interaction terms between BI and industry ecosystem dependency classifications.

Results

Descriptive Statistics and Preliminary Analysis

The mean BI index score is 38.4 (SD = 22.7), with considerable sectoral variation: agriculture and food firms record the highest mean BI scores (49.3), reflecting the advanced state of nature-positive certification in agri-food chains, while apparel and textiles record the lowest (27.1). European firms consistently score higher on the BI index (mean 48.6) than North American (33.2) or Asia-Pacific firms (29.4), reflecting the more advanced regulatory environment for biodiversity disclosure in the European

Union. The SCS composite shows a positive trend, with mean scores increasing from 42.1 in 2010 to 58.7 in 2022. Zero-order Pearson correlations confirm that BI is positively associated with SCS ($r = 0.58$, $p < 0.001$), Tobin's Q ($r = 0.41$, $p < 0.001$), and ROA ($r = 0.29$, $p < 0.001$). Variance inflation factors are all below 3.8, confirming the absence of problematic multicollinearity.

Biodiversity Integration and Supply Chain Sustainability (H1)

The system GMM estimates confirm a positive and significant effect of biodiversity integration on supply chain sustainability ($th1 = 0.43$, $SE = 0.06$, $p < 0.001$), supporting H1. A ten-point increase in the BI index is associated with a 4.3-point improvement in the SCS composite, equivalent to approximately one-third of a standard deviation improvement in SCS. The effect is robust across all three component sub-dimensions: supplier environmental compliance ($b = 0.38$, $p < 0.001$), resource efficiency ($b = 0.31$, $p < 0.001$), and supplier sustainability practices ($b = 0.44$, $p < 0.001$). The stronger effect on supplier sustainability practices relative to resource efficiency suggests that the governance diffusion mechanism operates primarily through supplier management rather than technological substitution, consistent with the relational governance literature emphasising buyer-supplier collaboration as the primary vehicle for supply chain sustainability improvement (Lund-Thomsen & Lindgreen, 2014). These findings provide the first large-sample econometric evidence that corporate biodiversity integration cascades through GVC governance to improve sustainability outcomes across chain segments.

Nature-Positive Business Models and Firm Value (H2)

The system GMM estimates reveal a positive and significant relationship between biodiversity integration and both Tobin's Q ($b = 0.019$, $SE = 0.004$, $p < 0.001$) and ROA ($b = 0.083$, $SE = 0.021$, $p < 0.001$), supporting H2. A ten-point improvement in the BI index is associated with a 0.19-unit increase in Tobin's Q and a 0.83 percentage point increase in ROA, holding all controls constant. For the median firm in the sample, this corresponds to an increase in market capitalisation of approximately USD 185 million and an increase in annual net income of approximately USD 28 million - economically significant magnitudes that validate the strategic case for biodiversity integration.

Temporal analysis reveals that the BI-Tobin's Q relationship strengthens significantly over the period. Splitting the sample into three sub-periods (2010 to 2014, 2015 to 2018, 2019 to 2022) shows BI coefficients of 0.011, 0.016, and 0.027 respectively, with the trend statistically significant (Chow test, $F = 4.83$, $p = 0.012$). This temporal acceleration is consistent with the hypothesis that regulatory and institutional developments, the SDGs in 2015, the Kunming-Montreal Global Biodiversity Framework in 2022, and TNFD guidance evolution, have progressively increased the market premium for nature-positive strategies, paralleling the dynamics documented for climate risk pricing (Giglio et al., 2021).

Mediation by Supply Chain Sustainability (H3)

The mediation analysis confirms that supply chain sustainability partially mediates the biodiversity-firm value relationship, supporting H3. The indirect effect of BI on Tobin's Q through SCS is positive and significant (indirect effect = 0.008, SE = 0.002, 95% bootstrapped CI [0.004, 0.013], $p < 0.001$), representing 42.1% of the total effect of BI on Tobin's Q. The direct effect remains significant after including SCS (direct effect = 0.011, $p < 0.01$), confirming partial rather than full mediation. For ROA, the indirect effect through SCS accounts for 38.4% of the total BI-ROA relationship, with the direct effect again remaining significant. The partial mediation finding indicates that biodiversity integration generates firm value through two concurrent pathways. The indirect pathway, operating through supply chain sustainability, captures the operational value creation logic of the NRBV: nature-positive practices reduce supply chain costs, improve resource efficiency, reduce compliance risk, and support premium pricing. The direct pathway likely reflects equity market repricing of biodiversity risk and opportunity as investors incorporate BI disclosures into valuation models, consistent with the asset pricing literature on ESG and environmental risk (Chava, 2014; Krueger et al., 2020). The co-existence of these two pathways underscores the multidimensional financial value of biodiversity integration, operating simultaneously through operational improvements and capital market mechanisms.

Industry Heterogeneity (H4)

Subsample analysis confirms that biodiversity integration effects are heterogeneous across sectors, supporting H4. The strongest BI-Tobin's Q effects are observed in agriculture and food production ($b = 0.028$, $p < 0.001$) and fisheries and aquaculture ($b = 0.031$, $p < 0.001$), the sectors with highest ecosystem dependency and most developed nature-positive certification infrastructure. Weaker but significant effects are observed in construction and infrastructure ($b = 0.009$, $p = 0.04$) and apparel and textiles ($b = 0.011$, $p = 0.03$), where ecosystem dependencies are more indirect. The interaction between BI and the ENCORE ecosystem dependency score is positive and significant ($b = 0.0024$, $p = 0.001$), confirming that the financial premium for biodiversity integration scales with ecosystem dependency. These heterogeneous effects provide granular guidance for investment prioritisation, indicating that financial returns on biodiversity strategy are highest where ecological dependency is most concentrated.

Discussion And Policy Implications

Nature-Positive Strategies as Sources of Competitive Advantage

The finding that biodiversity integration significantly improves both Tobin's Q and ROA provides the most comprehensive econometric evidence to date that nature-positive business models constitute sources of sustained competitive advantage within the NRBV framework (Hart, 1995; Hart & Dowell, 2011). The effect on Tobin's Q, which captures investor expectations of future competitive advantage, implies that equity markets recognise biodiversity integration as a forward-looking quality signal

that differentiates firms capable of navigating the tightening regulatory and ecological landscape from those exposed to escalating natural capital risks. The temporal acceleration of the BI-valuation relationship over 2010 to 2022 is consistent with the institutional maturation hypothesis, which predicts that environmental performance premiums strengthen as regulatory disclosure requirements, investor engagement frameworks, and civil society scrutiny intensify (Eccles et al., 2014; Giglio et al., 2021). Firms that defer biodiversity strategy integration risk not only the loss of first-mover valuation advantages but also increasingly material financial penalties associated with nature-related risk exposure.

GVC Governance as a Biodiversity Transformation Mechanism

The confirmation that biodiversity integration significantly improves supply chain sustainability across chain segments advances the empirical literature on GVC sustainability governance. The finding that the governance diffusion effect is strongest for supplier sustainability practices, reflecting relational governance through which lead firms set standards and build supplier capacity, is consistent with Gereffi et al.'s (2005) framework, which predicts that lead firm influence over supplier practices is greatest when governance involves significant supplier-specific investment and knowledge transfer. This has practical implications: governance mechanisms that build supplier ecological capability through technical assistance, co-investment, and long-term partnership relationships are likely to achieve greater supply chain sustainability improvements than compliance-only approaches.

The partial mediation finding is theoretically significant because it disentangles two distinct value-creation mechanisms that prior literature has conflated. The indirect pathway, operating through supply chain sustainability, reflects the operational value proposition of the NRBV: firms integrating biodiversity into supply chain governance generate resource efficiencies, reduce input cost volatility, mitigate supply disruption risks from ecosystem service degradation, and access premium markets demanding nature-positive credentials (Hart, 1995; Miemczyk et al., 2012). The direct pathway, which persists after controlling for supply chain sustainability, operates through capital market repricing of nature-related risk and opportunity. As institutional investors increasingly integrate biodiversity metrics into portfolio management, a trend accelerated by TNFD recommendations and expanding fiduciary duty interpretations that encompass systemic natural capital risks, firms with strong biodiversity integration command a valuation premium in Tobin Q independent of current accounting performance (Krueger et al., 2020; Chava, 2014). The co-existence of these two pathways has practical implications for how firms communicate biodiversity strategy to both operational and capital market audiences.

The industry heterogeneity findings add important granularity to the financial case for nature-positive investment. The substantially stronger BI-valuation effects in agriculture and food production ($b = 0.028$) and fisheries and aquaculture ($b = 0.031$)

relative to construction and textiles reflect the differential materiality of ecosystem services across production systems. For agri-food firms, biodiversity underpins pollination, soil health, and watershed regulation, all direct inputs to production, making biodiversity integration a commercial imperative rather than a reputational exercise. The ENCORE dependency scores used to construct the interaction term provide a ready-made toolkit for firms and investors seeking to prioritise biodiversity strategy investment by materiality, directing resources to the supply chain nodes and geographies where ecological dependencies are most concentrated and biodiversity integration generates the greatest financial return (NCFA, 2020; Chaplin-Kramer et al., 2019).

Policy and Managerial Implications

For corporate managers, the study demonstrates that biodiversity integration is a value-creating investment generating returns through both supply chain operational improvements and capital market recognition. Chief sustainability officers should embed nature-positive targets into business model design, supply chain governance frameworks, capital allocation processes, and executive incentive structures. The industry heterogeneity findings provide a clear prioritisation signal: the financial return on biodiversity strategy is highest in agriculture, food, and fisheries sectors with concentrated ecosystem dependencies. For supply chain managers, the mediation findings imply that the pathway from biodiversity commitments to financial value runs substantially through operational supply chain improvements. Supplier development programmes that build ecological capability, landscape-level conservation partnerships addressing shared ecosystem dependencies, and long-term procurement relationships creating incentives for supplier sustainability investment are all evidence-consistent instruments for capturing the financial co-benefits of sustainable supply chain management.

For investors and financial analysts, the capital market findings validate integration of biodiversity-specific metrics into equity valuation models. The progressive strengthening of the BI-valuation relationship suggests that biodiversity risk is increasingly priced, implying that portfolios systematically underweighting high-BI firms face growing mispricing risk as nature-related disclosures mature under TNFD frameworks. For policymakers, the study supports mandatory corporate biodiversity disclosure requirements as an accelerant for nature-positive business model diffusion. The corporate disclosure-to-valuation channel identified here implies that mandatory, standardised, and comparable biodiversity disclosures will strengthen market pricing of nature-related risks, creating stronger financial incentives for biodiversity integration than voluntary regimes. The EU Corporate Sustainability Reporting Directive's ESRS E4 biodiversity standard and mainstreaming of TNFD recommendations into securities regulation represent critical steps in this direction.

Conclusion

This study provides large-sample panel econometric evidence on the financial implications of nature-positive business model adoption within global value chains. Drawing on the NRBV and GVC theory, and employing system GMM estimation to address endogeneity, the study demonstrates that biodiversity integration significantly enhances supply chain sustainability, improves firm value through both operational and capital market channels, and that sustainable supply chain practices partially mediate the biodiversity-to-firm-value pathway. These effects are heterogeneous across industries, with the strongest financial returns concentrated in sectors with the greatest ecosystem dependency. The study makes four contributions. It advances the NRBV with the most comprehensive econometric evidence to date that ecological capabilities constitute measurable competitive advantage in contemporary GVC environments. It applies GVC theory to the biodiversity domain, demonstrating that GVC governance mechanisms effectively diffuse nature-positive practices across production networks. It identifies supply chain sustainability as the primary operational mechanism through which biodiversity integration creates financial value. And it documents the temporal acceleration of biodiversity-valuation dynamics, providing evidence of the progressive institutionalisation of nature-positive strategy as a financial quality signal.

Several limitations invite further research. The disclosure-based operationalization of biodiversity integration may inadequately capture the ecological quality of corporate nature-positive commitments, given the well-documented gap between disclosure and implementation in sustainability practice. Future studies should incorporate direct ecological outcome measures alongside disclosure proxies to assess whether financial returns reflect genuine ecological performance or disclosure management. The sample's bias toward large publicly listed multinationals limits generalizability to smaller firms; extending analysis to SMEs in agri-food and forestry GVCs would enrich the evidence base. The broader message is unambiguous: biodiversity integration is an empirically validated source of supply chain resilience, operational efficiency, and market valuation. As the regulatory architecture governing corporate biodiversity accountability matures, the financial divergence between nature-positive leaders and biodiversity laggards is likely to intensify, making the strategic imperative for nature-positive transformation ever more compelling.

Future research agendas should also address the role of institutional context in moderating the biodiversity-integration-to-firm-value relationship. The significant variation in BI index scores between European firms (mean 48.6) and Asia-Pacific firms (mean 29.4) suggests that the stringency of national biodiversity governance frameworks, including environmental regulation quality, enforcement capacity, and capital market disclosure requirements, materially conditions both the incentives to invest in biodiversity integration and the financial returns it generates. Studies employing multi-level modelling to separate firm-level, industry-level, and country-level determinants of biodiversity integration outcomes would advance theoretical understanding of the institutional architecture required to accelerate nature-positive

business model adoption at scale. Similarly, the temporal acceleration documented in the BI-valuation relationship over 2010 to 2022 warrants further investigation to determine whether it reflects progressive market learning, regulatory signalling, or genuine shifts in consumer and investor preferences for nature-positive brands and supply chains.

The findings of this study also have implications for the measurement and reporting standards that will shape the next generation of corporate biodiversity accountability. The TNFD recommendations acknowledge that biodiversity metrics are less mature than carbon metrics, with no single universally accepted measure analogous to tonnes of CO2 equivalent (TNFD, 2023). The composite BI index employed in this study, drawing on GRI 304 disclosures, CDP Supply Chain data, and TNFD-aligned disclosure quality scores, represents one approach to aggregating heterogeneous biodiversity information into a tractable analytical measure. As standardisation of biodiversity reporting improves under TNFD, ESRS E4, and related frameworks, researchers will have access to richer, more granular, and more comparable data that will enable more precise tests of the nature-performance relationship across the full spectrum of GVC participants, including the upstream agricultural and forestry producers who generate the majority of biodiversity impacts but receive the fewest direct financial incentives for nature-positive transformation under current market structures (Lambin et al., 2018; Lund-Thomsen & Lindgreen, 2014).

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