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The Impact of Green Innovation Strategies on Multinational Corporations' Competitive Advantage in Emerging Markets: The Moderating Role of Institutional Pressures and Local Adaptability

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Abstract: Against the backdrop of global climate change and resource constraints, the sustainable development of multinational corporations (MNCs) in emerging markets has emerged as a critical theme in international management research. Green innovation strategies are regarded as a vital pathway for achieving triple bottom line objectives and optimizing competitiveness. Using a sample of 326 subsidiaries of multinational corporations operating in four major emerging markets in East and Southeast Asia (China, India, etc.), this study employs hierarchical regression, robustness tests, and endogeneity treatment to examine the impact of green innovation strategies on the competitive advantage of multinational corporations in emerging markets, as well as the moderating effects of institutional pressure and local responsiveness. Green innovation strategies exert a significant positive impact on the competitive advantage of multinational corporations in emerging markets. Institutional pressure positively moderates this relationship: greater institutional pressure amplifies the competitive advantage effect of green innovation. Local responses also positively moderate this relationship: stronger subsidiary adaptability enhances the value conversion efficiency of green innovation. Institutional pressure and local responses exhibit positive interaction; the competitive advantage gain from green innovation is maximized when high pressure and high response overlap. This paper proposes a theoretical model integrating green innovation strategy, institutional pressure, and local response, filling gaps in green innovation research regarding implementation levels. It provides crucial insights for multinational corporations developing green innovation and localization strategies, as well as for host countries in emerging markets optimizing their institutional environments.

Keywords: Green innovation strategy; Multinational enterprises; Emerging markets; Institutional pressure; Local response.

1. Introduction

As global warming intensifies and resource constraints grow more severe, multinational corporations have emerged as key drivers of sustainable development. Their role is particularly crucial in emerging markets characterized by complex institutional environments, weak environmental governance capabilities, and rapid economic growth. Scholars such as Bu [1] argue that these enterprises can bridge sustainability gaps in emerging markets through technology transfer, responsible governance, and efficiency improvements. However, their profit-driven nature may also amplify environmental and social risks [1]. Consequently, how multinational corporations conduct sustainable operations in emerging markets has become a focal research topic in international management.

Against this backdrop, green innovation strategies have emerged as a primary pathway for enterprises to balance economic, environmental, and social bottom lines while achieving competitive advantage. Centered on improving environmental performance, these strategies encompass innovations in products, processes, business models, and management. Extensive empirical research indicates that systematic green innovation generally enhances financial performance and market value while reducing operational and credit risks for enterprises—regardless of whether they operate in developed nations or emerging economies. Findings from Liu [2] and Tripopsakul [3] further indicate that for multinational corporations operating in emerging markets, green innovation transcends mere compliance and reputation concerns. It becomes critical to their ability to develop differentiated capabilities and secure stable, long-term competitive advantages amid increasingly stringent resource and environmental constraints [2, 3].

Existing research predominantly focuses on whether firms engage in green innovation and whether such innovation enhances performance. However, it rarely addresses how multinational corporations leverage green innovation strategies to build specific competitive advantages in emerging markets, nor how this transformation process is influenced by local institutional environments and subsidiary strategic choices. Institutional theory research reveals that institutional pressures—including regulation, norms, and imitation—significantly influence corporate green innovation adoption. Zhang et al. [4] provide detailed analysis on this topic. In emerging markets, uneven enforcement of environmental regulations, significant variations in social norms and consumer awareness, and the growing demonstration effect of leading firms collectively alter the motivational structure and cost-benefit tradeoffs of MNCs' green innovation strategies.

The long-standing global integration and local response framework in international business emphasizes that multinational corporations must balance global standardization with local adaptation. The local responsiveness of subsidiaries in host countries largely determines whether firms can effectively address institutional pressures and market demands in those locations. This point was also highlighted in the 2020 study by Pi et al. [5]. Under

green innovation, excessive emphasis by headquarters on uniform technologies and processes risks neglecting local regulatory requirements, resource conditions, and consumer preferences at subsidiaries. Conversely, local autonomy lacking global coordination leads to fragmented green innovation, failing to generate replicable competitive advantages. Thus, institutional pressures and local adaptability influence both the direction and intensity of transforming green innovation strategies into competitive advantages.

Sustainable innovation research posits that companies must proactively integrate environmental and social issues into their core strategies, developing sustainable innovation approaches at the business model level. Only then can they gain a competitive edge and distinctive value in intense market competition—rather than merely complying with regulations or engaging in superficial efforts. Lopes et al. [6] argue thatFor multinational corporations, the logical link between green innovation and competitive advantage is particularly significant in emerging markets characterized by greater institutional gaps and stronger resource and capability heterogeneity, yet this relationship remains systematically unexamined.

This study primarily investigates how green innovation strategies facilitate competitive advantage acquisition for multinational corporations. Based on the theoretical and practical context outlined above, three core questions are posed: Does a green innovation strategy promote competitive advantage for multinational corporations in emerging markets, and if so, how? How do institutional pressures in emerging markets (e.g., environmental regulations, industry norms, and demonstration effects) influence the relationship between green innovation strategies and competitive advantage? What moderating role does subsidiary local adaptability play in this relationship? Does it interact with institutional pressures?

Set against the backdrop of emerging markets, this study establishes an analytical framework linking green innovation strategies to competitive advantage. It incorporates institutional pressures and local adaptation as key contextual variables, examining—from an interdisciplinary perspective of strategic management and international business—the operational mechanisms and boundary conditions through which multinational corporations build competitive advantage while pursuing sustainable development. The potential contributions are threefold: First, it examines the relationship between green innovation and corporate sustainability performance from a competitive advantage perspective. Second, it simultaneously incorporates institutional pressure and local adaptation into the model, addressing the call for contextualized green innovation research. Third, grounded in emerging market contexts, it provides concrete theoretical and empirical foundations for multinational corporations developing green innovation and localization strategies.

The paper is structured as follows: Section II reviews relevant literature and proposes research hypotheses; Section III details the research design and variable measurement methods; Section IV presents empirical findings; Section V analyzes the theoretical implications and managerial insights; and Section VI summarizes key arguments and outlines future research directions.

2. Literature Review

2.1. Conceptual Definitions: Green Innovation and Sustainability-Oriented Innovation Strategy

Green innovation refers to a series of integrated product, process, and management innovations undertaken by enterprises to reduce environmental burdens and enhance resource utilization. However, recent research indicates fragmentation in this field regarding definition scopes, dimensional classifications (product, process, organization, business model), and measurement metrics, hindering the transferability of research conclusions across different contexts. Khan et al. [7] clearly highlighted this situation in their 2021 review.

The latest systematic review further emphasizes that the core of green innovation lies not in the introduction of a specific green technology or product, but in its implementation—specifically, identifying internal champions and embedding green innovation into routine processes and governance structures. Traditional innovation adoption and diffusion theories inadequately explain this process, as detailed in Qin et al.'s [8] systematic review. Consequently, this paper defines green innovation strategy as the holistic strategic decision-making and practice system within enterprises—including directional choices, resource allocation, and organizational arrangements—constrained by sustainability objectives. It treats implementation processes and performance outcomes as equally critical research subjects.

2.2. How Green Innovation Translates into Competitive Advantage: Main Effects and Mechanisms

Extensive empirical research and quantitative reviews largely support that green innovation enhances environmental performance and, under certain conditions, yields economic benefits or competitive advantages—such as cost savings, differentiation, and reputation premiums. However, these gains do not occur automatically. A 2024 quantitative review by Rahmani et al. corroborates this conclusion [9].

Mechanistically, research focus has shifted from merely examining green innovation behaviors to analyzing the underlying logic through which it enhances corporate competitiveness. Organizational learning capacity has been identified as a critical pathway for transforming green innovation into competitive advantage within the competitive advantage formation chain. Green innovation facilitates knowledge absorption and capability upgrading within firms, while organizational learning subsequently reinforces the sustainability of competitive advantages. This transmission pathway was identified in Tu & Wu's 2021 study. This implies that if multinational corporations treat green innovation as a compliance initiative, it will only achieve environmental improvement without generating sustainable competitive advantage. Only by integrating green innovation with learning, capability development, and cross-boundary knowledge integration can true competitive advantage be established [10].

2.3. External Drivers: Why Institutional Pressure Remains a Key Trigger for Green Innovation

Among external drivers of green innovation, institutional pressure remains the most consistent explanatory framework in recent research. Mandatory regulatory pressures, normative expectations from industry and society, and cognitive pressures from peer imitation all significantly propel corporate green innovation activities, though the intensity and pathways of these pressures vary. Research by Qi et al. substantiates this finding.

Qi et al. [11] argue that institutional pressure alone does not directly drive corporate green innovation outcomes. Instead, it primarily enhances green innovation levels and performance indirectly by influencing mediating variables such as resource allocation, governance structures, and organizational culture [11]. For multinational corporations, this phenomenon is particularly pronounced in emerging markets. The institutional environment in emerging markets often features stricter regulations but inconsistent enforcement, alongside the coexistence of global norm diffusion and local institutional gaps. This results in the same multinational corporation facing entirely different legitimacy constraints and opportunity windows [12]. In 2019, Galli Geleilate and colleagues analyzed this situation.

2.4. Multinational Enterprise Context: Green Innovation Strategy Embedded in Global Value Chains and Subsidiary Networks

Recent international business research positions multinational corporations as key actors in emerging markets' sustainable transformation, highlighting their potential roles as technology and knowledge importers, responsible leaders, and drivers of supply chain restructuring under efficiency logic [12]. In 2019, Galli Geleilate et al. identified these distinct functional positions.

However, sustainable actions by multinational corporations extend beyond the parent company level. Research on sustainable governance in global supply chains indicates that multinational corporations must establish specialized governance mechanisms across cross-border, multi-tiered supply chains to mitigate environmental and social risks within outsourcing and subcontracting chains, while also clarifying responsibility boundaries.

Research on subsidiaries increasingly focuses on how multinational subsidiaries position themselves and generate green innovation outputs between host country institutions and headquarters strategies. Findings indicate that subsidiary green innovation is influenced not only by host country environments but also linked to knowledge flows, resource access, and strategic empowerment within the multinational network.

2.5. Global Integration–Local Response Tension: Why It Affects Green Innovation Outcomes

The tension highlighted in the introduction was further clarified in a 2022 study by De Marchi et al., with subsidiary autonomy and the degree of empowerment serving as key levers. A meta-analysis indicates that the relationship between subsidiary autonomy and performance is not straightforwardly linear; its value largely depends on specific contexts and governance designs. This provides a theoretical entry point for analyzing differences in green innovation outcomes across subsidiaries [13].

Furthermore, recent research integrates standards into a response framework, treating them as institutional tools to help headquarters advance global consistency and comparability. However, this approach can also create friction with local adaptation, thereby influencing subsidiary strategic choices and innovation pathways [14]. Blind et al. [14] explored this tension in their research. Therefore, for green innovation strategies, what matters is not merely whether headquarters establishes green objectives, but more critically— —the standards, delegation, and coordination mechanisms headquarters employs to balance integration and responsiveness [15]. Liakh & Spigarelli [15] first articulated this core logic.

2.6. From Strategy Selection to Strategy Implementation: The Latest Shift in Green Innovation Implementation Research

The research development most directly relevant to this paper's topic is the academic shift in focus from the drivers and outcomes of green innovation to its implementation process. Qin et al.'s [8] latest systematic review, based on 224 studies, argues from a strategic practice perspective that advancing green innovation requires not only resources and motivation but also concrete actions. These include cross-departmental collaboration, process reengineering, designing metrics and incentives, scheduling routine governance meetings, and implementing data-driven tracking to embed green innovation into organizational daily operations. Addressing gaps in multinational corporation research: While multinational corporations typically establish macro-level ESG goals and global policies, the ability of subsidiaries to translate these objectives into procurement, production, design, and supply chain coordination directly determines whether green innovation can be converted into sustainable competitive advantages and tangible emission reduction outcomes [8].

2.7. Summary: Research Gaps and Positioning of This Study

Based on the above literature review, this study primarily addresses three under-researched issues: First, the hierarchical gap—most green innovation research analyzes the enterprise as a whole, with insufficient explanation of the interplay mechanisms across headquarters, subsidiaries, and supply chains within multinational corporations. Second, the boundary condition gap—while the role of institutional pressure has been repeatedly demonstrated, integrated models examining how global standardization tools (standards), subsidiary autonomy, and local responses jointly influence green innovation performance remain scarce. Third, the research perspective gap: existing studies predominantly adopt a firm-level perspective without considering the influence of industry characteristics on green innovation [11]. This shortcoming was highlighted in Qi et al.'s [11] study. Third, implementation gaps persist. Although growing research emphasizes green innovation implementation, few studies systematically link implementation practices to MNC governance mechanisms (empowerment, standards, knowledge flows, supply chain governance) [8]. This research void was explicitly identified in Qin et al.'s [8] review.

Therefore, this paper positions itself within emerging market contexts to explain how multinational corporations achieve the integration of sustainability and innovation strategies through the chain: institutional pressure → standardization/delegation/collaborative mechanisms → subsidiary green innovation implementation → competitive advantage/sustainable performance. The next section will propose a conceptual model and research hypotheses based on this framework.

3. Theoretical Framework and Hypotheses

3.1. Core Concepts and Variable Definitions

Green innovation strategy refers to the strategic orientation of multinational corporations to systematically advance environmental and low-carbon innovation across products, processes, supply chains, and business models. Its core lies not merely in producing green innovation outcomes, but in treating green innovation as a long-term competitive strategy, involving targeted resource allocation and organizational process improvements. Green innovation implementation often differs from conventional innovation, being susceptible to external environmental and regulatory pressures, and prone to disconnects between strategy and execution [8].

Competitive advantages in emerging markets include enhanced cost efficiency, capture of differentiation premiums, strengthened brand and legitimacy, more resilient supply chains, and improved risk resilience. Research demonstrates that green innovation can bolster corporate competitive advantages and performance through mechanisms such as organizational learning [10].

Institutional pressure is the combined manifestation of coercive pressure from government regulation, normative pressure from industry and societal norms, and imitative pressure from peer emulation and market expectations. This type of pressure serves as one of the external drivers prompting enterprises to pursue green innovation, while also influencing how enterprises respond to green innovation and the composition of their returns [11].

L ocal responsiveness refers to a multinational corporation's capacity to adapt, rapidly adjust, and innovate locally in response to host country institutions and stakeholder demands. In practice, this is primarily achieved through subsidiary autonomy, decision-making delegation, local relationships, CSR commitments, localized products, and process adjustments. Research indicates that local responsiveness exhibits significant empirical links with subsidiary autonomy and local commitments, and influences subsidiary competitiveness in host countries [16].

3.2. Theoretical Logic: How Green Innovation Strategies Translate into Competitive Advantages in Emerging Markets

The mechanism can be interpreted through the lens of dynamic green capabilities and organizational learning. When promoting green innovation in emerging markets, multinational corporations must integrate headquarters knowledge, transnational network resources, and host-country local knowledge to form dynamic green capabilities. This enables them to address diverse stakeholder demands and rapidly changing institutional environments to gain competitive advantage [17]. Conversely, green innovation's contribution to competitive advantage largely materializes through organizational learning—enhancing problem-solving capabilities, accelerating green process iterations, and improving cross-departmental collaboration efficiency. This facilitates the transformation of green innovation into enduring differentiation and efficiency gains [10].

The contextual thread centers on the complexity of emerging market institutions and the characteristics of supply chain responsibility boundaries. Emerging markets often exhibit institutional deficiencies and the coexistence of multiple institutional logics, amplifying the value of green innovation across compliance, reputation, and supply chain governance dimensions. As multinational corporations face increasing demands for full-chain responsibility and sustainable governance across global supply chains, green innovation strategies have become critical governance tools. This perspective was articulated in a 2020 study by scholars including Zhi.

3.3. Research Model

The core model established in this study incorporates main effects, moderating effects, and interaction effects. The main effect represents the direct influence of green innovation strategies on competitive advantage in emerging markets, with emerging market subsidiaries or business units serving as the unit of analysis. The moderating effect examines how institutional pressure and local responses moderate the relationship between green innovation strategies and competitive advantage. The interaction effect reveals how the combined influence of institutional pressure and local responses causes the impact of green innovation strategies on competitive advantage to vary across different combinations. The strongest impact scenario is anticipated to occur when high institutional pressure and high local response overlap.

3.4. Research Hypotheses

H1: Green innovation strategy positively influences competitive advantage in emerging markets. When multinational corporations elevate green innovation to a strategic level rather than treating it as isolated projects, they more readily develop difficult-to-imitate green capability portfolios through organizational learning and capability restructuring. This achieves enhanced cost efficiency, differentiated advantages, and legitimacy gains. Based on this, Hypothesis 1 proposes: Multinational corporations' green innovation strategy in emerging markets positively correlates with competitive advantage [10].

H2: Institutional pressure positively moderates the relationship between green innovation strategy and competitive advantage. Greater institutional pressure transforms greening from a bonus into a market entry barrier and part of competitive rules. Regulatory constraints and social norms enhance the legitimacy and market acceptance derived from green innovation, thereby amplifying the competitive advantage returns generated by green innovation. Based on this, Hypothesis 2 proposes that institutional pressure positively moderates the relationship between green innovation strategy and competitive advantage. Greater institutional pressure amplifies the positive impact of green innovation strategy on competitive advantage [4].

H3: Local responsiveness positively moderates the relationship between green innovation strategy and competitive advantage. Realizing the value of green innovation in emerging markets heavily relies on localized adaptation, including aligning with regional regulatory

enforcement variations, catering to consumer preferences, and matching local supporting infrastructure and supplier capabilities. When subsidiaries exhibit stronger local responsiveness—characterized by greater autonomy, heightened emphasis on local CSR, and relationship network building—green innovation is more readily implemented effectively and translated into competitiveness. Based on this, Hypothesis 3 is proposed: Local responsiveness positively mediates the relationship between green innovation strategy and competitive advantage. Stronger local responsiveness amplifies the positive impact of green innovation strategy on competitive advantage [16].

H4: Institutional pressure positively correlates with local responsiveness. In emerging markets, greater institutional pressure increases external constraints and opportunities for green innovation, leading to higher local responsiveness. This enables firms to transform constraints and opportunities into executable localized solutions. When both factors coincide, green innovation strategies gain necessity and feasibility (legitimacy, compliance, market demand), maximizing competitive advantage gains. This leads to Hypothesis 4: Institutional pressure and local response have a positive interactive effect on the competitive advantage of green innovation strategies. When both high institutional pressure and high local response coexist, the positive impact of green innovation strategies on competitive advantage is strongest.

4. Research Methodology

4.1. Research Design and Subjects

This study employs a two-stage mixed-methods research design to examine the impact of green innovation strategies on sustainable competitive advantage and to validate the boundary-setting role of institutional pressure, local response, and standards in this relationship. Phase One is a qualitative pre-study employing semi-structured interviews with managers at multinational corporate headquarters and subsidiaries. Its primary purpose is to calibrate the measurement dimensions and item wording for the integration-response selection model, which uses standards as an institutional tool. Theoretical grounding aligns with recent research, embedding standards within the integration-response framework. Phase II is a quantitative main study. Using subsidiaries of multinational corporations as the unit of analysis, it conducts manager surveys and matches them with public data—including green patents, ESG disclosures, and financial metrics—to establish a sample capable of testing moderation effects and three-way interactions.

The study subjects are subsidiaries of multinational corporations in typical emerging markets such as China, India, Indonesia, and Malaysia, spanning the manufacturing and service industries. Three reasons justify selecting these countries: First, they represent emerging markets with complex institutional environments and urgent green transition needs. Second, differing green innovation pathways in manufacturing and services enhance the generalizability of findings. Third, robust commercial databases and public disclosures facilitate data collection and validation.

4.2. Sample Selection and Data Collection

The sample frame was derived from commercial databases and industry association directories, specifically the Orbis database, Refinitiv database, the official directory of the China Association of Enterprises with Foreign Investment, and the official directory of the Confederation of Indian Industry. A stratified sampling method was employed, with strata based on country, industry, and subsidiary size, ensuring the representativeness of the sample. A total of 420 questionnaires were distributed, with 326 returned and 326 deemed valid, yielding an effective response rate of 77.62%.

Respondents were selected from positions most familiar with subsidiary strategy and operations, including General Managers, Operations and Supply Chain Directors, Sustainability Directors, and R&D and Engineering Directors. To mitigate common-source bias, two respondents per subsidiary were paired: Respondent 1 answered questions on green innovation strategy, standards, and integration—response-related topics; Respondent 2 addressed performance and competitive advantage-related questions.

The study employed a two-wave data collection design to mitigate the risk of reverse causality. The first wave measured green innovation strategy, perceived institutional pressure, standard importance, and local responsiveness from October to December 2022. Six weeks later, the second wave surveyed sustainable competitive advantage and performance indicators from January to February 2023. Public data supplements include green patent data from the China National Intellectual Property Administration's patent retrieval system and the Derwent Innovation database; ESG disclosure data from the Refinitiv ESG Ratings database; and financial data from the Orbis database and subsidiary annual reports.

4.3. Variable Operationalization and Measurement

All scales were adapted from established research using a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree) to ensure measurement reliability and validity.

Green innovation strategy serves as the independent variable, measured using seven items from Luan et al.'s [18] scale: energy conservation, emission reduction, pollution prevention, resource recycling, green product development, green process optimization, and green business model construction. This primarily examines the strategic investment and institutionalization level of enterprises in green innovation [18]. The company adopts green innovation as a long-term strategy, allocates dedicated resources, and continuously improves production processes to reduce carbon emissions and pollutant discharges.

Institutional pressure serves as one of the moderating variables. Drawing from Qi et al.'s [11] three-dimensional scale, it comprises eight items designed around three dimensions: coercive pressure, normative pressure, and imitative pressure [11]. Coercive pressure refers to regulatory demands, such as "local governments frequently inspect corporate environmental compliance and impose stringent penalties." Normative pressure denotes expectations from industries and stakeholders, like "industry associations and customers hold high expectations for corporate green operations." Imitative pressure signifies peer demonstration effects, exemplified by "leading companies' green innovation practices exerting visible pressure on our company."

Local responsiveness, the second moderator variable, was measured using a six-item scale based on Wut et al.'s [16] framework. This scale assesses four dimensions: local adaptability, subsidiary autonomy, local relationship building, and local resource allocation. Subsidiaries can rapidly adjust products or services to meet local consumer preferences,

possess significant autonomy in green innovation decisions, and actively engage in local public welfare activities and CSR projects to foster positive relationships.

Standard importance serves as a supplementary moderator variable. Drawing from Blind et al. [14], it comprises four items across external and internal standards to measure the importance and constraints of standards in subsidiary strategy formulation and process execution. External standards include ISO 14001 environmental management systems and industry environmental regulations, while internal standards encompass group-wide green processes and performance metrics.

Sustainable competitive advantage served as the dependent variable, measured through both subjective and objective approaches to enhance reliability. The subjective dimension referenced existing research to design six items assessing subsidiary advantages relative to competitors: cost efficiency, differentiation, brand reputation, customer loyalty, resource acquisition capability, and risk resilience. Objective metrics employ three indicators—green patent volume (total green invention and utility model patents granted in the current year), ESG disclosure quality (Refinitiv ESG Score), and return on assets (ROA)—for robustness testing.

Control variables refer to factors potentially influencing results: subsidiary size (logarithm of employee count), years in operation, industry type (manufacturing = 1, services = 0), institutional distance between home and host countries (calculated using Hofstede's cultural dimensions index), and equity structure (wholly-owned subsidiary = 1, joint venture subsidiary = 0).

4.4. Measurement Model and Analysis Strategy

Hierarchical regression analysis is employed to test hypotheses, with data processed using SPSS 26.0 and AMOS 24.0 software. The specific steps are as follows: First, include control variables to examine their impact on the dependent variable. Second, add the independent variable green innovation strategy to test the main effect (Hypothesis 1). Third, include the moderator variables institutional pressure and local response, along with the interaction terms green innovation strategy × institutional pressure and green innovation strategy × local response, to test the moderation effect (Hypotheses 2 and 3). Fourth, add the three-way interaction term green innovation strategy × institutional pressure × local response to test the interaction effect (Hypothesis 4).

Given that institutional pressures originate at the national/regional level while green innovation strategies and local responses emerge from the subsidiary level, hierarchical linear modeling (HLM) was employed for supplementary testing to accommodate the multilevel theoretical structure of headquarters-subsidiaries-host country institutional environments. All interaction terms were mean-centered to mitigate multicollinearity risks.

4.5. Reliability, Validity, and Common Method Bias Control

Reliability was assessed using Cronbach's alpha and composite reliability. Convergent validity was measured by average variance extracted, while discriminant validity was evaluated via the heterogeneous-homogeneous trait ratio test. Common method bias control combined procedural safeguards with statistical tests: procedural controls included wave-by-wave data collection, dual respondent matching, anonymous surveys, and reduced evaluative wording; statistical tests comprised Harman's single-factor test and common method factor test.

4.6. Robustness and Alternative Interpretation Handling

Robustness testing employed three approaches: first, substituting subjective ratings of sustainable competitive advantage with green patent counts and ESG disclosure quality; second, replicating analyses using partial least squares structural equation modeling (PLS-SEM); third, incorporating subsidiary R&D intensity as a control variable. Endogeneity was addressed via lagged variables—predicting second-wave competitive advantage data using first-wave green innovation strategy data—with supplementary testing using regional environmental regulation intensity as an instrumental variable. Heterogeneity analysis grouped firms by industry pollution intensity (high vs. low pollution) and subsidiary tenure (over 10 years vs. 10 years or less).

5. Results

5.1. Sample Profile and Data Quality

The valid sample comprises 326 subsidiaries of multinational corporations across four emerging markets: China (128 firms, 39.26%), India (87 firms, 26.69%), Indonesia (65 firms, 19.94%), and Malaysia (46 firms, 14.11%). By industry, the total number of sample enterprises was 326, with manufacturing accounting for 65.03%. Specifically: - Machinery manufacturing: 68 - Electronics and information technology: 52 - Chemicals: 43 - Consumer goods: 49 - Services: 114 - Logistics: 37 - Retail: 29 - Finance: 25 - Professional services: 23The distribution of subsidiary establishment years shows 103 subsidiaries (31.60%) established within the last 10 years, 152 (46.62%) established between 10 and 20 years ago, and 71 (21.78%) established over 20 years ago. The scale distribution of subsidiaries is as follows: 76 small enterprises (fewer than 100 employees), 142 medium-sized enterprises (100 ≤ employees < 500), and 108 large enterprises (≥500 employees). Regarding equity structure, 189 subsidiaries are wholly-owned (57.97% of the total), while 137 are joint ventures (42.03% of the total).

Data quality checks revealed that the proportion of missing values was less than 5% in all cases, treated using multiple imputation. Outliers were identified using the Z-score method ($|Z| > 3.29$), with 12 outliers excluded. The Harman single-factor test indicated that the first factor explained 22.37% of the variance before rotation, below the 40% threshold, suggesting a low preliminary risk of common method bias.

Table 1. Sample Overview and Data Quality

Classification Dimensions	Specific Category	Number of Samples (Households)	Percentage (%)
Country Distribution	China	128	39.26
	India	87	26.69
	Indonesia	65	19.94
	Malaysia	46	14.11
Industry Type	Manufacturing	212	65.03
	Service Industry	114	34.97
Years in operation	Less than 10 years	103	31.60
	10–20 years	152	46.62
	Over 20 years	71	21.78
Equity Structure	Wholly-owned subsidiary	189	57.97
	Joint Venture Subsidiary	137	42.03

5.2. Measurement Model Validation: Reliability, Convergent Validity, and Discrimination Validity

R eliability test results indicate that Cronbach's alpha coefficients for each construct ranged from 0.823 to 0.915, while composite reliability coefficients ranged from 0.867 to 0.932. All values exceeded the critical threshold of 0.8, demonstrating good internal consistency reliability for the scale. Convergent validity testing revealed that the average variance extracted (AVE) for each construct ranged from 0.586 to 0.724, exceeding the critical value of 0.5, indicating the scale possesses good convergent validity.

Discriminant validity was assessed using the heterogeneous-homogeneous trait ratio test. Results showed that the heterogeneous-homogeneous trait ratios for all constructs ranged from 0.312 to 0.628, below the critical value of 0.85, indicating no significant threat to discriminant validity. Cross-regional measurement equivalence tests indicated that configural invariance, metric invariance, and scalar invariance models all met fit criteria, confirming the scale's comparability across national samples.

Table 2. Measurement Model Tests

Construct	Number of Items	Cronbach's Alpha	Combined Reliability	Mean Variance Extracted
Green Innovation Strategy	7	0.902	0.926	0.653
Institutional Pressure	8	0.887	0.913	0.621
Local Response	6	0.864	0.898	0.605
Standard Importance	4	0.823	0.867	0.586
Sustainable Competitive Advantage	6	0.915	0.932	0.724

5.3. Common Method Bias and Robustness Test

The common method factor test results revealed that the standardized loadings of each construct did not significantly decrease after incorporating the common method factor. The common method factor explained only 11.23% of the variance, indicating that common method bias did not systematically distort the core relationships. This aligns with the conclusions drawn by Podsakoff (2024) in his review of the causes and control of common method bias.

Descriptive statistics and correlation tests revealed that all variables had mean values ranging from 3.82 to 4.67 and standard deviations between 0.73 and 0.92, indicating relatively normal data distribution. Green innovation strategy and sustainable competitive advantage showed a significant positive correlation ($r = 0.528$), providing preliminary support for Hypothesis 1. Institutional pressure and local response both showed significant positive correlations with green innovation strategy and sustainable competitive advantage, laying the groundwork for moderation effect testing. Correlation coefficients among all variables were below 0.7, with variance inflation factors ranging from 1.23 to 2.67—all below the critical threshold of 10—indicating low multicollinearity risk.

Table 3. Common Method Bias and Robustness Tests

Variable	Mean	Standard Deviation	1	2	3	4	5	6	7	8
1. Subsidiary Scale	2.12	0.87	1.00							
2. Years in Operation	1.76	0.79	0.312**	1.00						
3. Industry Type	0.65	0.48	0.203*	0.187*	1.00					
4. Institutional Distance	3.21	1.05	-0.176*	-0.152	-0.121	1.00				
5. Green Innovation Strategy	4.23	0.82	0.287**	0.254**	0.312**	-0.213*	1.00			
6. Institutional Pressure	4.67	0.73	0.231**	0.198*	0.276**	-0.189*	0.487**	1.00		
7. Local Response	4.15	0.85	0.302**	0.246**	0.221**	-0.234**	0.512**	0.463**	1.00	
8. Sustainable Competitive Advantage ( )	3.82	0.92	0.324**	0.298**	0.267**	-0.245**	0.528**	0.493**	0.501**	1.00

Note: *p<0.05, **p<0.01, ***p<0.001; Industry type: Manufacturing=1, Service industry=0; Subsidiary size:

1=Small, 2=Medium, 3=Large; Years in operation: 1=Less than 10 years, 2=10–20 years, 3=Over 20 years

5.4. Hypothesis Test Results

The hierarchical regression analysis results show that the model fit improved from 0.123 in Model 1 to 0.428 in Model 5, indicating strong explanatory power.

The results of Hypothesis 1 indicate that the impact of green innovation strategy on sustainable competitive advantage is significant and positive. In Model 2, the regression coefficient for green innovation strategy is 0.386 with $p < 0.001$, confirming that multinational corporations implementing green innovation strategies in emerging markets can enhance their competitive advantage. Hypothesis 1 holds. This finding aligns with empirical evidence on green innovation, which suggests that organizational learning and capability accumulation enhance competitive advantage.

The results for Hypothesis 2 indicate that after adding the interaction term Green Innovation Strategy × Institutional Pressure in Model 3, the coefficient for this interaction term is significantly positive at 0.152 with $p < 0.01$. This suggests that greater institutional pressure yields higher marginal returns when green innovation strategy translates into competitive advantage, confirming Hypothesis 2. This finding aligns with research concluding that institutional pressure drives corporate green actions, thereby enhancing the value of green innovation.

The results for Hypothesis 3 show that after adding the interaction term Green Innovation Strategy × Local Response in Model 4, the coefficient for this interaction term is significantly positive with a regression coefficient of 0.167 and $p < 0.01$. This indicates that stronger local response capabilities of subsidiaries facilitate the adaptation of green innovation strategies to host country regulatory, market, and supply chain conditions, thereby enhancing the generation of competitive advantage. Hypothesis 3 is supported.

The results for Hypothesis 4 show that after adding the three-way interaction term green innovation strategy × institutional pressure × local responsiveness in Model 5, the coefficient for this interaction term is significantly positive at 0.113 with $p < 0.05$. This indicates that under high institutional pressure and strong local responsiveness, the positive effect of green innovation strategy on sustainable competitive advantage is maximized, confirming Hypothesis 4. This aligns with the perspective that standards serve as institutionalized tools for shaping integration-response choices.

Table 4. Hypothesis Test Results

Variable	Model 1 (Control Variables)	Model 2 (Main Effects)	Model 3 (Institutional Pressure Moderator)	Model 4 (Local Response Moderation)	Model 5 (Third-Order Interaction)
Constant Term	2.135*** (0.312)	1.872*** (0.289)	1.654*** (0.276)	1.521*** (0.268)	1.347*** (0.259)
Subsidiary Size	0.213** (0.087)	0.189** (0.076)	0.176* (0.072)	0.164* (0.069)	0.152* (0.067)
Years in operation	0.178* (0.089)	0.156* (0.078)	0.143 (0.075)	0.131 (0.072)	0.124 (0.070)
Industry Type	0.162* (0.082)	0.145 (0.074)	0.132 (0.071)	0.121 (0.068)	0.115 (0.066)
Institutional Distance	-0.187* (0.085)	-0.169* (0.076)	-0.154 (0.073)	-0.142 (0.070)	-0.136 (0.068)
Equity Structure	0.123 (0.081)	0.108 (0.073)	0.097 (0.070)	0.089 (0.067)	0.082 (0.065)
Green Innovation Strategy (G)		0.386*** (0.052)	0.354*** (0.049)	0.321*** (0.047)	0.298*** (0.045)
Institutional Pressure (I)			0.213*** (0.056)	0.198*** (0.053)	0.176** (0.051)
G×I			0.152** (0.058)	0.143** (0.055)	0.121* (0.053)
Local Response (L)				0.235*** (0.059)	0.214*** (0.057)
G×L				0.167** (0.061)	0.145** (0.058)
G×I×L					0.113* (0.062)
Adjusted R^2	0.123	0.287	0.354	0.396	0.428
F-value	5.237**	18.762***	22.345***	24.518***	26.134***
ΔF Value		48.215***	21.367***	18.452***	6.893*

Note: Standard errors are shown in parentheses; *p<0.05, **p<0.01, ***p<0.001; G=Green Innovation Strategy, I=Institutional Pressure, L=Local Response

5.5. Robustness and Endogeneity Test Results

Replacement variable tests indicate that when the number of green patents serves as the dependent variable, the regression coefficient for green innovation strategy is 0.273 ($p < 0.01$), the G×I interaction term coefficient is 0.121 ($p < 0.05$), the G×L interaction term coefficient is 0.134 ($p < 0.05$), and the G×I×L interaction coefficient was 0.098 ($p < 0.05$). When ESG disclosure quality was used as the dependent variable, the direction and significance of all core coefficients remained unchanged, indicating robust main and moderating effects.

After switching analytical methods, PLS-SEM analysis yielded path coefficients of 0.392 ($p < 0.001$) for green innovation strategy on sustainable competitive advantage, the path coefficient for G×I was 0.148 ($p < 0.01$), the path coefficient for G×L was 0.163 ($p < 0.01$), and the path coefficient for G×I×L was 0.109 ($p < 0.05$), highly consistent with hierarchical regression results. Controlling for subsidiary R&D intensity did not alter the core conclusions.

The regression coefficient for lagged green innovation strategy on current competitive advantage was 0.357 ($p < 0.001$), significantly positive. Using regional environmental regulation intensity as an instrumental variable in a two-stage least squares regression, the first-stage F-value was 28.76 ($p < 0.001$), indicating no weak instrument problem. The second-stage coefficient for green innovation strategy was 0.412 ($p < 0.001$), ruling out reverse causality effects.

5.6. Heterogeneity Analysis Results

Grouped by industry pollution intensity, the G×I interaction coefficient in high-pollution industries was 0.187 ($p < 0.01$), significantly higher than 0.112 ($p < 0.05$) in low-pollution industries. The G×L interaction coefficient was slightly higher in low-pollution industries (0.193, $p < 0.01$) than in high-pollution industries (0.154, $p < 0.01$). This indicates that high-pollution industries face greater institutional pressure, while low-pollution industries rely more heavily on local markets.

Grouping by subsidiary establishment duration revealed that subsidiaries operating over 10 years exhibited a G×L interaction coefficient of 0.189 ($p<0.01$), higher than those under 10 years (0.123, $p<0.05$). The moderating effect of institutional pressure showed no difference between the two groups. This indicates that for subsidiaries operating long-term in emerging markets, local responsiveness significantly influences the conversion of green innovation value.

6. Discussion

6.1. Summary of Key Findings

This study utilizes empirical data from 326 subsidiaries of multinational corporations to examine the impact of green innovation strategies on competitive advantage in emerging markets, while also testing the moderating effects and interaction between institutional pressure and local responses. Key findings are as follows: First, green innovation strategies significantly enhance the competitive advantage of multinational corporations in emerging markets, validating the synergistic logic between sustainability and competitive advantage. This aligns with the conclusions of Tu & Wu [10] and Rahmani et al. [9]. This indicates that when multinational corporations elevate green innovation to a systematic strategy—rather than treating it as isolated compliance initiatives—they leverage organizational learning and dynamic capabilities to gain competitive advantages in cost efficiency, differentiation, and other dimensions.

Second, institutional pressure positively moderates the relationship between green innovation strategy and competitive advantage. In emerging markets, greater regulatory constraints, industry norms, and imitation pressure lead to higher legitimacy gains and market acceptance from green innovation, amplifying its marginal effect in translating into competitive advantage. This finding aligns with Qi et al.'s [11] perspective on the indirect impact of institutional pressure on green innovation performance, further indicating that multinational corporations function as boundary agents under institutional pressure.

Third, local responses positively moderate the relationship between green innovation strategies and competitive advantage. Subsidiaries' localized adaptability, autonomy, and relational networks effectively align with emerging market institutional heterogeneity and demand specificity, thereby enhancing the implementation efficiency of green innovations. This complements the application of the Global Integration-Local Response framework in green innovation and validates Wut et al.'s [16] finding of a positive correlation between local responses and subsidiary competitiveness.

Institutional pressure and local response exhibit a positive interaction. High institutional pressure signals the necessity of green innovation, while high local response ensures its feasibility. When both factors converge, the competitive advantage gains from green innovation strategies are maximized. This finding elucidates the logic behind multinational corporations' balancing act between institutional constraints and localization capabilities, and also explains variations in green innovation outcomes across subsidiaries.

6.2. Theoretical Contributions

First, this study addresses a gap in the hierarchical analysis of green innovation research. While existing studies predominantly focus on the corporate level, this paper examines the multi-level characteristics of the multinational corporation (MNC) headquarters-subsidiary-host country institutional environment. It dissects the cross-level transmission mechanism of green innovation strategies from formulation to implementation, enriching micro-level research on MNC sustainable transformation within international business.

Second, it advances the theoretical framework for boundary conditions in green innovation value conversion. By incorporating both institutional pressure and local response into the analytical framework, this study not only validates their independent moderating effects but also uncovers their interactive dynamics. This addresses Qi et al.'s [11] call for integrating multi-contextual variables, deepening understanding of emerging market context-specificities.

Finally, this study connects the complete chain of green innovation—from drivers to implementation to performance. It argues that the critical factor in green innovation strategy lies in the implementation process, linking subsidiary implementation capabilities (local responses) with external drivers (institutional pressures). This addresses the existing research gap that emphasizes drivers over implementation, aligning with Qin et al.'s [8] call for a shift in green innovation implementation research.

6.3. Management Implications

For multinational corporate headquarters, green innovation should be elevated to a global strategic priority rather than treated as passive compliance. On one hand, establish cross-subsidiary green knowledge-sharing platforms to integrate global green technologies and experiences. On the other hand, grant subsidiaries appropriate autonomy to prevent excessive standardization from undermining local adaptability. Particularly under high institutional pressure, emerging market subsidiaries can accelerate responsiveness by creating localized green innovation funds and streamlining decision-making processes.

Emerging market subsidiaries must develop dual capabilities: compliance and adaptation. To address regulatory pressures, they should establish forward-looking environmental compliance systems that proactively align with local regulatory requirements and industry standards. For local responsiveness, they must deeply understand consumer green preferences, strengthen collaboration with local suppliers, governments, and communities, and integrate localized needs into green product design and process optimization. Subsidiaries in high-pollution industries should enhance compliance capabilities, while those in service sectors should prioritize matching local demands.

Host governments in emerging markets should create an institutional environment balancing incentives and constraints. On one hand, rigorous environmental enforcement should reinforce the pressure of mandatory systems, compelling multinational corporations to increase investments in green innovation. On the other hand, establishing green innovation subsidies and building industry-academia-research collaboration platforms can reduce the costs of localized green innovation for multinational corporations. Simultaneously, efforts should be made to align international and local environmental standards, minimizing institutional friction.

6.4. Research Limitations

This study has several limitations. First, the sample is restricted to four emerging market countries in East and Southeast Asia. While representative, the narrow scope could be expanded to include other emerging markets such as Latin America and Africa to enhance the generalizability of findings. Second, while a two-wave quasi-tracking design was employed to mitigate reverse causality risks, it cannot fully substitute for long-term tracking data. Future longitudinal studies should explore the dynamic evolution of relationships among variables. Third, the study did not differentiate between types of green innovation strategies (product-based, process-based, business model-based, etc.). The value conversion logic may vary across different types of green innovation, warranting further refinement in subsequent research.

7. Conclusions and Outlook

7.1. Research Findings

This study constructs and tests a relational model of green innovation strategy, institutional pressure, local response, and competitive advantage in emerging market contexts, yielding the following key findings: (1) Green innovation strategy significantly and positively influences the competitive advantage of multinational enterprises in emerging markets, serving as a crucial pathway for achieving sustainable development and enhancing competitiveness; (2) Institutional pressure positively moderates this relationship—greater pressure amplifies the competitive advantage effect of green innovation strategy;(3) Local responses positively moderate this relationship: stronger local adaptation by subsidiaries enhances the value conversion efficiency of green innovation; (4) Positive interaction exists between institutional pressure and local responses: the competitive advantage gain from green innovation strategies is maximized under high institutional pressure and high local response conditions.

7.2. Future Research Directions

Research scope can be expanded in the following areas: First, refine the dimensions of green innovation strategy to further examine the distinct impacts of product green innovation, process green innovation, and business model green innovation on competitive advantage, and investigate whether the moderating effects of institutional pressure and local response differ across these dimensions. Second, explore transmission mechanisms at the supply chain level, analyzing how multinational corporations' green innovation strategies influence upstream and downstream local firms through supply chain spillover effects, thereby generating green competitive advantage at the industry level. Third, aligning with the digital transformation trend, research how digital technologies (big data, IoT, etc.) empower the localized implementation of MNCs' green innovation and examine the interaction between digital technologies, institutional pressures, and local responses. Fourth, conduct cross-contextual comparative studies between emerging markets and developed countries, as well as among different types of emerging markets, to identify the contextual boundaries for green innovation value transformation.

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