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GREEN INNOVATION, SME ENVIRONMENTAL PERFORMANCE, AND COMPETITIVE ADVANTAGE:

MODERATING ROLE OF GOVERNMENT GREEN POLICY AND INDUSTRY PRESSURE

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ABSTRACT: The growing global environmental challenges, combined with increased competition in emerging markets, has sparked a new understanding of environmental management in small and medium-sized enterprises (SMEs) and made it a source of innovation, rather than a compliance requirement. Green innovation, which is defined as the creation of environmentally favourable product, process and organizational innovation, that at the same time create a competitive advantage, has become the key enabler for SMEs for attaining both environmental sustainability and competitive advantage. However, the

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boundary conditions when, how and for which SMEs, green innovation leads to better environmental performance and competitive advantage are yet to be theorized and empirical investigation of these conditions is still limited especially for the industrial SMEs in Pakistan which are growing at a very rapid rate. This research aims to develop and then empirically test a theoretically integrated dual moderation framework that examines (1) the direct influence of green innovation on SME environmental performance (EP) and competitive advantage (CA); (2) the mediational role of environmental performance in the green innovation-competitive advantage pathway; (3) the moderating role of government green policy (GGP) as an institutional enabler that enhances the effectiveness of green innovation and (4) the moderating role of industry pressure (IP) as a market-competitive driver that improves the returns of green innovation to CA. The study is designed using a stratified random sample of 486 SMEs in five major industrial sectors of Pakistan: Textiles, Pharmaceutical, Food Processing, Chemicals and Engineering, and was conducted using a multiple sources survey design (Wave 1 - GI and Moderators, Wave 2 - EP and CA) with a four-month delay. The study theoretical framework is based on Natural Resource-Based View (NRBV; Hart, 1995), Dynamic Capabilities Theory (Teece et al., 1997), and Institutional Theory (DiMaggio & Powell, 1983). Mainly, PLS-SEM (SmartPLS 4.0) analysis method was used, followed by the Hierarchical Regression Analysis (HRA) and Hayes (2022) PROCESS Macro Model 59 moderation testing with 5,000 BCa bootstrap iterations of dual moderation. Results show that the variable of green innovation has a significant and positive positive predictive value for the variable of environmental performance (beta = 0.521, $p < 0.001$) and competitive advantage (beta = 0.389, $p < 0.001$). The GI-CA relationship is to a large extent mediated by environmental performance (indirect effect = 0.198, 95% BCa CI [0.142, 0.261] and PM = 33.7%). Government green policy is a significant moderator for the GI-EP pathway (beta 0.213, $p<0.001$) and industry pressure is a significant moderator for the EP-CA pathway (beta 0.187, $p<0.001$). Dual moderated mediation is evidenced when both moderators enhance the pathway between GI-EP-CA. The results contribute to the NRV and Dynamic Capabilities Theory in SME environment and provide practical implications for the managers of SMEs, environmental policy makers, and industrial sector associations in Pakistan.

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Keywords: *Green Innovation, SME Environmental Performance, Competitive Advantage, Government Green Policy, Industry Pressure, Natural Resource Based View, Dynamic Capabilities, PLS-SEM, Pakistan SMEs, Environmental Management, Sustainability.*

1. INTRODUCTION

The global call to action for corporate environmental sustainability is reshaping the competitive landscape of small and medium-sized enterprises (SMEs) who represent more than 90% of the world's businesses, 50% of GDP in most economies and 60-70% of employment (OECD, 2023; UNEP, 2023). In an emerging economy like Pakistan where SMEs make up 99.7% of all businesses, contribute around 40% to its GDP, employ 78% of the non-agricultural labor force, and generate 25% of export earnings (Pakistan Bureau of Statistics [PBS], 2023; SMEDA, 2023), the environmental performance of SMEs is not only a matter of corporate responsibility but also a national sustainable development imperative.

However, the environmental footprint of all SMEs accounted for an estimated 35% of national industrial pollution, and they consume 42% of industrial energy, and have higher per-unit environmental footprint than large businesses, which is a combined challenge of environment management capacity limitations and competitive pressures that make it unfeasible for SMEs to invest in environmental management (Ministry of Climate Change, 2021; World Bank, 2024). Green innovation has been defined as innovation in products, processes, services or business models that simultaneously lowers environmental impacts and generates new value by implementing ecological efficiency, resource productivity and sustainable competitive differentiation (Chen et al., 2006; Rennings, 2000; Schiederig et al., 2012) and has been identified as the theoretically most powerful mechanism by which SMEs can reconcile the perceived trade-offs between environmental responsibility and competitive performance (Chen, 2008; Driessen & Hillebrand, 2013; Porter & van der Linde, 1995).

It is therefore theoretically legitimate to consider green innovation as a way to gain competitive advantage in addition to simply incurring compliance costs, as the Porter Hypothesis suggests that environmental regulation can stimulate innovation and competitive advantage (Porter & van der Linde, 1995; Rennings, 2000). The empirical conditions under which this hypothesis is a correct one, however, remain under-specified:

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those aspects – e.g. institutional policy environment (government green policy) and market competitive force (industry pressure) – that amplify or attenuate the returns of green innovation to environmental performance and competitive advantage, remain under-specified, especially in the case of emerging economy SME sectors. The following two theoretically underspecified boundary conditions on the green innovation-competitive advantage relationship are of particular interest.

Theoretically, the effectiveness of green innovation is predicted to be amplified through government green policy, as it provides: market pull for green products; green R&D investment risk reduction through green fiscal measures; competitive advantages for first green movers; and green enforcement environments that prevent green free-riders. However, the role of government green policy as a moderating factor on the green innovation-environmental performance pathway has been only sparsely studied in the context of SMEs, especially in the institutional environment of a developing economy with significant variations in policy design, policy enforcement capacity, and the credibility of the policy (Horbach et al., 2012; Rennings, 2000). Second, Dynamic Capabilities Theory (Teece et al., 1997) theoretically expects industry pressure, which includes competitive pressure from green innovating competitors, customer pressure for greener offerings, environmental pressures of supply chain partners and sectoral environmental conditions, to increase the return to green innovation's competitive advantage through market-competitive conditions, where green innovation, manifested in differences in environmental performance, leads to premium price, customer retention and market share gains.

However, the moderating effect of industry pressure on the environmental performance-competitive advantage pathway and its interaction effect with government green policy on the dual outcome profile of green innovation has not been investigated in the literature of SMEs in Pakistan. This study has five original contributions. First, it builds and validates a multi-dimensional Green Innovation Index (GII) which is specially designed for Pakistani SME settings that incorporates three dimensions of Green Innovation namely Product, Process and Organisational Green Innovations.

Second, it develops and tests dual moderation model where the first moderation is of government green policy which moderates the path of GI-EP and the second moderation is

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of industry pressure which moderates the path of EP-CA which is the first dual moderation model in Pakistani SME environmental studies.

Third, it provides the first causal pathway evidence in a Pakistani cross-sectoral SME panel by testing the theoretical mediation between green innovation and competitive advantage by environmental performance.

Fourth, it synthesizes the NRBV, Dynamic Capabilities Theory and Institutional Theory into a single coherent theory that together comprise green innovation capabilities' development (NRBV), sustainability (Dynamic Capabilities) and magnification of contexts (Institutional Theory). Fifth, it provides the first multi-sector, multi-wave and multi-source empirical evidence of the effectiveness of green innovation in five selected industrial sectors of Pakistani manufacturing SMEs. The article continues as follows: Section 2 discusses the theoretical foundations and empirical literature. The conceptual framework and hypotheses are presented in Section 3. Section 4 details methodology. Section 5 presents results. Findings and implications are discussed in Section 6. At the end of section 7, recommendations are given.

2. THEORETICAL FOUNDATIONS AND LITERATURE REVIEW

2.1 Natural Resource-Based View (NRBV): Green Capabilities as Competitive Assets

The Natural Resource-Based View (NRBV) of the firm considers green capabilities as one of the key factors used to gain competitive advantages. Most widely influential of the theoretical frameworks in environmental strategy research is the Natural Resource-Based View (NRBV) (Hart, 1995) which is an extension of Barney's (1991) Resource-Based View (RBV) to include the natural environment as a primary constraint and strategic context in which firms gain competitive advantage. Hart (1995) highlights three interconnected environmental strategies—PPP, product stewardship and SD—and different dynamic capabilities underpinning each of these that create different types of competitive advantage.

Pollution prevention capabilities (continuous environmental process improvement) lead to cost advantage because of waste reduction, energy efficiency and productivity increase of operation (Hart, 1995; Porter & van der Linde, 1995). Product stewardship capabilities, such as life-cycle management, eco-design and extended producer responsibility, create differentiation advantage by changing the positioning of the environmental products,

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improving brand reputation and enhancing the quality of supply chain relations. Sustainable development capabilities (that is, clean technology development and clean market creation) deliver first-mover advantages in new sustainable markets through environmental innovation leadership (Hart, 1995; Hart & Dowell, 2011) that is proprietary in nature.

Extrapolating NRBV to SME green innovation, firms that invest in green product, process and organisation innovation create environmental capabilities that possess the following characteristics: valuable (that is, environmental capabilities reduce costs and help contribute to increased revenues); rare (that is, the green innovative processes are not widely available); inimitable (that is, environmental capabilities are system-level, not individual); and organizationally embedded (that is, environmental capabilities are tacit knowledge). Because their environmental performance dimension places significant demands on the real change on the way that companies operate, green innovation-based competitive advantages are therefore expected to be more sustainable than traditional innovation advantages, which have less ability to be emulated than product or marketing innovations (Chen, 2008; Hart & Dowell, 2011).

2.2 Dynamic Capabilities Theory: Building and Renewing Green Innovation Capacity

Dynamic Capabilities Theory (Teece et al., 1997; Teece, 2007) focuses on how firms create, integrate, and redeploy resources to meet changing environmental conditions. Theoretically, dynamic capabilities, namely "the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al., 1997, p. 516) are particularly important for the green innovation process, since the environmental regulatory landscape, the green technology frontier and consumer environmental expectations are continuously and rapidly evolving, which requires firms not only to sense and seize emerging green opportunities, but also to reconfigure their innovation capabilities accordingly (Teece, 2007, Chen & Chang, 2013). Dynamic capability development is activated by industry pressure: the competitive urgency of green innovation capability development is triggered when firms are facing increasing green competitive pressure from rivals, customers and supply chain partners, which push them to develop and renew green innovation capability in a more comprehensive and speedy way

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than is the case in low green competitive pressure firms (Driessen & Hillebrand, 2013; Teece et al., 1997).

This theory is used as a foundation for the moderating effect of industry pressure, which is expected to amplify the effect of using green capability on the environment (which is the outcome of green capability deployment) to market-competitive returns to green capability investment on the market (which is the competitive advantage).

2.3 Institutional Theory: Policy Environments and Green Innovation

The second theory is Institutional Theory that views policy environments as a conducive condition for Green Innovation. Institutional Theory (DiMaggio & Powell, 1983; North, 1990; Scott, 2014) offers an explanation as to why organizations choose specific practices by means of three isomorphic processes: coercive, normative, and mimetic. If we apply the institutional theory to green innovation, the assumption is that, when government green policy is enacted, it imposes coercive institutional pressure that drives SMEs to make innovations that go further than those provided by market mechanisms by themselves – the regulatory compliance motivation. At the same time, incentive-based institutional pushes in the form of green fiscal incentives, voluntary environmental programmes, and government green procurement preferences provide financial incentives for green innovation. This can be understood in terms of the moderating role of government green policy in the green innovation-environmental performance pathway: green innovation investments are more likely to lead to improvements in environmental performance in environments where green policies are stronger and enforceable, since free-riding competitors can be prevented from not complying with these policies, and such policies can also lower the expense of reaching the environmental performance levels (Horbach et al., 2012; Porter & van der Linde, 1995).

2.4 Green Innovation: Dimensions and SME Relevance

Green innovation can be identified as product innovation (designing and developing products with less lifecycle environmental impact and environmental superior), process innovation (developing production and operational processes that utilize less energy, produce less waste, and emit less pollution; Chen et al., 2006; Rennings, 2000; Schiederig et al., 2012) and organizational innovation (developing environmental management systems, sustainability reporting, and green supply chain management that make

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environmental responsibility part of the organizational routine and culture; Chen et al., 2006; Rennings, 2000; Schiederig et al., 2012). Green process innovation is most readily available for SMEs as this does not demand high initial investments in R&D and yields rapid benefits of energy and material efficiency, which in turn lead to cost-reductions (Chen, 2008; Driessen & Hillebrand, 2013). Although more money needs to be invested, green product innovation offers more market positioning and premium pricing opportunities, which leads to a greater competitive differentiation. Green organizational innovation gives systemic embedding of environmental practices which makes sure that green innovation initiatives produce not just episodic but rather sustained improvements in environmental performance (Chen et al., 2006; Schiederig et al., 2012).

2.5 SME Environmental Performance

Green innovation investments (GI) are known to positively impact SME environmental performance, which is the actual result of environmental management-related activities of a firm, such as the reduction of energy consumption, greenhouse gas (GHG) emissions, water usage, waste generation and pollution output (Horbach et al., 2012; Rennings, 2000). But there is considerable methodological heterogeneity in the literature: studies use objective measures of environmental performance such as energy bills, waste manifests, emissions inventories or management perception of environment, third-party environmental audit scores, and indicators of certification status (ISO 14001, LEED, sector specific environmental standards). Such methodological diversity leads to an inconsistent effect size estimation, and cross study comparison is difficult. This study uses a multi-item, self-reported environmental performance scale that incorporates data from both available objective indicators and the comprehensive measurement of environmental performance in the context of Pakistani SMEs (Horbach et al., 2012; Tung et al., 2014).

2.6 Competitive Advantage in SME Environmental Strategy

Green innovation has been shown to provide a competitive advantage to a firm in several ways, including via cost leadership, differentiation or niche focus strategies (Porter, 1985). Cost advantage is the reduction of operational expenses due to the energy efficiency, waste reduction and resource productivity gains that are created by green process innovation. Premium environmental product positioning, green brand equity and the preference in supply chain and customer loyalty brought by the green product and brand positioning

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innovativeness originate the differentiation advantage (Chen, 2008; Porter, 1985). First-mover advantage is created by early green tech and market position leader, leading to patent protection, learning curve and customer relationship entrenchment. In a SME context, Chen (2008) shows that green competitive advantage is significantly more effective in industries with a higher level of consumer environmental consciousness – indicating that industry pressure, in particular by the environmentally conscious customers, contributes to magnifying the competitive advantage returns of green innovation.

2.7 Government Green Policy

The government green policy, defined in this study, includes five policy instruments: environmental regulation, market-based instruments, green fiscal measures, voluntary measures and green innovation support facilities (Porter and van der Linde, 1995; Rennings, 2000). The important policy instruments for greening in the institution are: National Environmental Quality Standards (NEQS) are enforced by the provincial Environmental Protection Agencies (EPAs) in Pakistan, climate change vulnerability index (CCVI) assessment program developed by SMEDA, alternative energy development board (AEDB) renewable energy incentives, Pakistan standards and quality control authority (PSQCA) environmental certification schemes (Ministry of Climate Change, 2021).

2.8 Industry Pressure

Industry pressure, which refers to the competitive and supply chain environmental pressures which firms face from other market actors, functions through four channels: 1) competitor pressure: environmental pressures exerted by rivals and demanding imitations or competitive displacement; 2) customer pressures; pressures from customers for greener products, environmental certificates, or audits in supply chains; 3) supplier pressures; pressures from other market actors in supply chains that are oriented towards environmental improvements in the production process; and 4) sectoral standards pressures, from environmental codes in industry associations or environmental norms within the profession or sector in which the firm acts (Driessen & Hillebrand, 2013; Teece et al., 1997). International demand from customers (EU Green Deal supply chain standards, US environmental import requirements, GCC green procurement mandates) impose the greatest pressure on industry - particularly on export-oriented SMEs - for

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industrial green innovation, where domestic industry regulatory enforcement has not, so far, acted as a driver for innovation (SMEDA, 2023; World Bank, 2024).

2.9 Research Gap

> This is motivated by 4 critical gaps: (1) The combined effect of Government green policy and Industry pressure as dual moderators of GRI's mediating role in the general effect of green innovation on competitive advantage has not been explored yet in Pakistan's context of SMEs; (2) The mediating role of environmental performance between GRI and competitive advantage has not been tested yet using moderated mediation design in Pakistani SMEs; (3) The psychometric validation of the multi-dimensional Green Innovation Index in Pakistani institutional, regulatory, and sectoral context has not been done yet; and (4) The effect of GRI on competitive advantage across 5 major industrial SME sectors in Pakistan has not been compared yet. This study covers all four gaps with a detailed multi-wave, multi-sector and multi-source research design.

3. CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

3.1 Conceptual Framework

The integrated model of dual moderation is shown in Figure 1. The main independent variable is Green Innovation (GI), which is represented by a three dimensional composite index (product, process, organizational innovation). The ultimate dependent variable is Competitive Advantage (CA) which is operationalised in terms of three dimensions namely cost, differentiation and positioning. The GI-CA pathway is mediated by Environmental Performance (EP), which refers to energy efficiency, emission reduction, waste minimization, and resource productivity outcomes. The pathway from government Green Policy (GI-EP pathway) is moderated by the Government Green Policy (GGP), while EP-CA pathway (second-stage moderation) is moderated by Industry Pressure (IP) resulting in a dual moderation model which has been tested using Hayes (2022) PROCESS Model 59. The conceptual framework combines NRBV (GI-EP capability-performance relationship), Dynamic Capabilities Theory (IP moderating EP-CA conversion), and Institutional Theory (GGP moderating GI-EP policy effectiveness).

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[Figure 1: Dual Moderation Framework — GI → [GGP] → EP → [Industry Pressure] → Competitive Advantage]

Green Innovation → [Moderated by Gov. Green Policy] → Environmental Performance → [Moderated by Industry Pressure] → Competitive Advantage.

3.2 Hypotheses

3.2.1 Green Innovation and Environmental Performance

The integrated model of dual moderation is shown in Figure 1. The main independent variable is Green Innovation (GI), which is represented by a three dimensional composite index (product, process, organizational innovation). The ultimate dependent variable is Competitive Advantage (CA) which is operationalised in terms of three dimensions namely cost, differentiation and positioning. The GI-CA pathway is mediated by Environmental Performance (EP), which refers to energy efficiency, emission reduction, waste minimization, and resource productivity outcomes. The pathway from government Green Policy (GI-EP pathway) is moderated by the Government Green Policy (GGP), while EP-CA pathway (second-stage moderation) is moderated by Industry Pressure (IP) resulting in a dual moderation model which has been tested using Hayes (2022) PROCESS Model 59. The conceptual framework combines NRBV (GI-EP capability-performance relationship), Dynamic Capabilities Theory (IP moderating EP-CA conversion), and Institutional Theory (GGP moderating GI-EP policy effectiveness).

H1: Green Innovation (GI) has a continued and profound direct impact on SME Environmental Performance (EP) in Pakistan.

3.2.2 Green Innovation and Competitive Advantage

NRBV (Hart, 1995) and Dynamic Capabilities Theory (Teece et al., 1997) suggest that green innovation can result in competitive advantages in three parallel routes. Cost advantage by operating efficiency, where the green process innovation save energy and material during the manufacturing process which in turn improve the cost per unit of production and avoid waste treatment cost and reduce compliance cost. Green value propositions can lead to differentiation advantage: Green product innovation can lead to geo-segment/premium pricing, customer loyalty and enhancement of brand equity. First-

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mover advantage by way of environmental leadership: companies who take first steps in a specifically green innovation can place themselves on learning curve benefits, patent portfolios and market positioning that provide long-lasting competitive moats against companies who take later steps in green innovation (Chen, 2008; Porter, 1985). To date, Chen (2008), Driessen and Hillebrand (2013), and Schiederig et al. (2012) report encouraging positive GI-CA relationships in a variety of industrial SME situations.

> **H2:** There is a strong direct positive influence of Green Innovation (GI) on Competitive Advantage (CA) of the SMEs in Pakistan.

3.2.3 Environmental Performance and Competitive Advantage

The Environmental performance and competitive advantage is a new field of study in environmental economics. Environmental performance, as manifested through reductions in energy, emissions, waste and pollution achieved, provides competitive advantage in a number of ways related to the market and operations. Cost advantage is direct effect of environmental performance: Verified energy savings, waste reduction, and resource productivity improvements have an immediate impact on the per unit cost of production (Hart, 1995; Porter & van der Linde, 1995). Market advantage comes from a credible environmental performance evidence; the EP metrics achieved are verifiable environmental claims that enable green brand positioning, customer trust and supply chain qualification. Regulatory advantage is related to the environment performance superiority of SMEs; having good EP records leads to lower regulatory compliance cost, faster permit processing and preferential treatment in government green procurement (Horbach et al., 2012; Rennings, 2000).

> **H3:** Environmental Performance (EP) has a great positive impact on Competitive Advantage (CA) among the Pakistani SMEs.

3.2.4 Mediating Role of Environmental Performance

The value-creating intermediary mechanism of green innovation investments for the acquisition of competitive advantage returns is the environmental performance. The direct competitive advantage impact of green innovation, such as cost savings and product

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differentiation, is significantly furthered by the direct environmental performance impact that it brings — verified environmental performance can be translated into market-credible green claims and can help with positioning and supply chain qualification that would not otherwise be possible with the intent or design behind green innovation (Hart, 1995; Porter, 1985). Mediation supports the NRBV hypothesis which posits that green capabilities (innovations) lead to competitive advantages mainly because of the environmental performance outcomes they deliver than because of the novelty of innovations or signaling investment (Hart & Dowell, 2011; Rennings, 2000).

H4: There is a significant mediating role of 'Environmental Performance (EP)' in between 'Green Innovation (GI)' and 'Competitive Advantage (CA)' in case of Pakistani SMEs.

3.2.5 Moderating Role of Government Green Policy

Strong government green policy is expected to intensify the effect of green innovation investments on the environmental performance through four institutional mechanisms as predicted by Institutional Theory (DiMaggio & Powell, 1983). Regulatory enforcement makes it more difficult for competitors to reach the same market positions as green innovators in the absence of any environmental innovation, which enhances the relative environmental performance advantage of green innovators. Green fiscal incentives lower the cost to reach environmental performance milestones, thus permitting green innovators to get more EP for the same investment in innovation. Green innovators' EP achievements are made visible and credible to market actors through voluntary program infrastructure (eco-labelling, environmental management standards) that allows for verification and communication. Green public procurement securities demand for high-EP products, which helps to strengthen the revenue business case to achieve environmental performance (Horbach et al., 2012; Porter & van der Linde, 1995; Scott, 2014).

H5: Green Innovation (GI) and Environmental Performance (EP) are positively related and Government Green Policy (GGP) positively moderates this relationship, meaning the positive relationship between Green Innovation and Environmental Performance is amplified as the level of Government Green Policy increases.

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3.2.6 Moderating Role of Industry Pressure

Dynamic Capabilities Theory (Teece et al., 1997) predicts that industry pressure can accelerate the process of the conversion of environmental performance into competitive advantage – largely because industry pressure can transform environmental performance differentiation into premium competitive returns. When facing high industry pressures, such as customers' preference for green products, competitor's leadership in green innovation and environmental certification of the supply chain, achieved environmental performance turns into a market qualification rather than just a nice-to-have brand attribute (Driessen & Hillebrand, 2013; Teece et al., 1997). This competitive context drives up returns to EP-CA; in a competitive environment, gaining access to a market (qualification to supply chains that demand environmental certification), pricing power (premiums over conventional alternatives) and switching costs (investment in environmental performance verification) are all competitive factors that drive up returns. In low pressure situations, the same environmental performance results do not bring the same competitive returns since market actors do not consider environmental performance when they purchase products (Porter, 1985; Chen, 2008).

H6: The industry pressure (IP) is positively moderating between the environmental performance (EP) and competitive advantage (CA), and the moderating effect of industry pressure is significantly stronger in the positive relationship between environmental performance and competitive advantage.

3.2.7 Dual Moderated Mediation

The result predicts a dual moderated mediation model: The indirect path of EP to competitive advantage is simultaneously moderated by government green policy (first-level moderator) and industry pressure (second-level moderator). The dual moderated mediation predicts the maximum amplification of the GI-EP-CA chain (green innovation leading to EP improvement and EP improvement to CA return), in that green innovation leads to greater EP improvement (H5), and EP improvement leads to greater CA return (H6), and the compound effect is greater than either or both moderators would be. This dual moderation architecture represents the most theoretical novel prediction and the most important empirical contribution of the study.

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H7: An indirect pathway from Green Innovation to Competitive Advantage via Environmental Performance is simultaneously moderated by Government Green Policy (GGP) and Industry Pressure (IP), thereby resulting in the strongest mediated indirect pathway in the combination of high-GGP and high-IP.

4. RESEARCH METHODOLOGY

4.1 Research Design and Sampling

The design of this study is a time-lagged, multi-source, multi-sector survey. Four months elapsed between waves in the time-lagged design (Wave 1 represented green innovation, government green policy, and industry pressure; Wave 2 represented environmental performance and competitive advantage), as this design helps to control for common method variance issues and the causal arrows for the tested relationships can be more defensibly ordered (Podsakoff et al., 2003). Within-source bias is further minimised with multi-source data collection – CEO/owner-managers provide ratings on green innovation (Wave 1) and environmental managers (where present) or senior operational managers provide ratings (Wave 2) on EP and CA. The cross-sectoral design involving five different industrial SME sectors allows for sectoral heterogeneity analysis and gives greater generalizability of findings to other contexts than just one industrial sector.

The target population are SECP-registered and SMEDA-certified SME's (0-250 employees) from the 5 major manufacturing industries including Textiles and Garments (Faisalabad, Lahore clusters), Pharmaceuticals (Lahore and Karachi), Food Processing (All over Pakistan), Chemicals and Petrochemicals (Karachi, Multan), and Engineering Goods (Sialkot, Gujranwala). The samples were selected using stratified random sampling with the following strata: sector (proportional to sector size distribution), geographic cluster (Punjab 48%, Sindh 31%, KPK 12%, Balochistan 9%) and firm size (micro: 1-9 employees 30%, small: 10-49 employees 45%, medium: 50-250 employees 25%). Sample size was determined using GPower 3.1 (Faul et al., 2007) with parameters: f2 = 0.15, alpha = 0.05, power = 0.95, and 16 predictors, yielding minimum n = 349. This sample can be considered large enough given that the final sample obtained (486 SMEs out of 560 contacted) had a 13.2% drop between waves.

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4.2 Measurement Instruments

4.2.1 Green Innovation Index (GII)

Green Innovation was assessed by a 21 item scale that consisted of three dimensions of innovation adapted from Chen et al. (2006), Rennings (2000), and Schiederig et al. (2012) with the context modifications of Pakistan. Green Product Innovation - (7 items): eco-design implementation; recyclable/biodegradable material substitution; development of energy efficient products; evaluating the environmental impact of products along the whole supply chain; green labelling and certification; reducing the carbon footprint of products; increasing the number of environmentally superior product lines. Green Process Innovation (7 items): introduction of cleaner production technology, energy efficiency improvement measures, water use reduction measures, waste minimization and recycling measures, pollution control technology investments, carbon emission reduction measures, and environmental management system (ISO14001) implementation.

Green Organizational Innovation (7 items): green organizational culture development, green supply chain management, environmental performance measure systems, stakeholder environmental engagement programs, environmental training and development, green innovation strategy formulation and sustainability reporting adoption. Everything is scored on a 5 point Likert scale (1 = Not at all to 5 = Extensively adopted). Cronbach's alpha = 0.923 (overall composite).

4.2.2 Environmental Performance (EP)

The 12-item environmental performance scale was adapted from the scales developed by Tung et al. (2014) and Horbach et al. (2012) and covered four dimensions: Energy Performance (3 items: decrease energy consumption for the same amount of product; increase the use of renewable energy; achievement of energy cost reduction); Emissions Performance (3 items: decrease greenhouse gas emissions; decrease air pollutants; improve carbon intensity per unit revenue); Waste Performance (3 items: decrease solid waste generation; decrease liquid effluent waste; improve waste recycling rate); and Resource Productivity (3 items: increase raw material usage efficiency; decrease water consumption; decrease use of packaging material). Three-point comparisons were made on 5-point scales (1 = significantly worse, 5 = significantly better) by respondents. EP ratings for a 15%

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random subsample (n = 73) were cross-validated with available EPA monitoring records and energy utility bills to minimize the error of self-reporting. Cronbach's alpha = 0.891.

4.2.3 Competitive Advantage (CA)

Competitive advantage was assessed by a 15-item scale on the three dimensions of advantage: Cost Advantage (5 items: cost reduction ability of green products; energy cost advantage; material efficiency advantage; regulatory compliance cost advantage; waste treatment cost savings); Differentiation Advantage (5 items: premium pricing ability for green products; brand reputation advantage; customer loyalty advantage; supply chain qualification advantage; green certification premium); and Market Positioning Advantage (5 items: market share growth in green product segments; success in entering green markets; export market green qualification; government procurement qualification; ESG investor/partner attraction). Everything is rated relative to the major competitors of the SME on a 5-point scale (1 = Significantly inferior to 5 = Significantly superior). Cronbach's alpha = 0.897.

4.2.4 Government Green Policy (GGP)

Positive measures are being taken to reduce the environmental footprint of the Government. Government Green Policy was evaluated with a 12-item measuring scale which included the environmental regulation enforcement strength, the severity of penalties for non-compliance with environmental regulation, the frequency of environmental regulation monitoring, the availability of eco-labelling program, the preference for green procurement by government, the environmental management system promotion by government, the public sector environmental certification requirements, the access to funding for clean technology research and development, and the support for green innovation by government. Everything measures on 5 point Likert scales (1 = Very weak/absent to 5 = Very strong/comprehensive). Cronbach's alpha = 0.874.

4.2.5 Industry Pressure (IP)

Industry pressure was measured by a 10 item scale based on the four sources of pressure defined by Driessen and Hillebrand (2013) and Teece et al. (1997): Competitor Pressure (3 items: competitor green innovation leadership, competitor green product superiority, threat of green market displacement); Customer Pressure (3 items: customer demands for

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environmentally certified products, customer supply chain environmental audit requirements, customer willingness to pay green premium); Supplier Pressure (2 items: supplier environmental standard requirements, supply chain partner environmental certification demands); and Sectoral Standards Pressure (2 items: industry association environmental code stringency, environmental certification requirements in the sector). Cronbach's alpha = 0.863.

4.3 Analytical Strategy

Analytical strategy comprised of four sequential analytical stages. Stage 1: CFA measurement model assessment using AMOS 26.0 (Convergent validity: AVE > 0.50, CR > 0.70; Discriminant validity: Fornell-Larcker criterion and HTMT < 0.85; Model fit: Chi-squared/df < 3.0, RMSEA < 0.06, CFI/TLI > 0.95, SRMR < 0.08). Stage 2: PLS-SEM (SmartPLS 4.0) estimation of structural models using 5000 bootstrapping iterations with standardized path coefficients, t-values, R-squared, effect sizes (Cohen's f-squared) and predictive relevance (Q-squared via blindfolding). Stage 3 – Mediation testing (H4) using PROCESS Macro Model 4 with 5,000 BCa bootstrap iterations. Stage 4: Dual moderated mediation testing (H5, H6, H7) using PROCESS Macro Model 59 (two simultaneous moderators conditioning the mediated pathway), including conditional indirect effects at all four combinations of moderator levels (Low-GGP/Low-IP; Low-GGP/High-IP; High-GGP/Low-IP; High-GGP/High-IP), index of moderated mediation for each moderator, and Johnson Neyman plots for continuous moderators.

5. EMPIRICAL RESULTS

5.1 Sample Profile

Table 1: SME Sample Profile (N = 486)

Characteristic	Category	n	% / Mean (SD)
Sector	Textiles & Garments	138	28.4%
	Food Processing	107	22.0%
	Engineering Goods	89	18.3%
	Chemicals	82	16.9%
	Pharmaceuticals	70	14.4%
Firm Size	Micro (1-9 employees)	146	30.0%

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Characteristic	Category	n	% / Mean (SD)
	Small (10-49 employees)	219	45.1%
	Medium (50-250)	121	24.9%
Firm Age	< 5 years	112	23.0%
	5-10 years	189	38.9%
	> 10 years	185	38.1%
Location	Punjab (Lahore, Fsd.)	233	47.9%
	Sindh (Karachi)	151	31.1%
	KPK / Balochistan / Other	102	21.0%
Ownership	Family-owned	341	70.2%
	Partnership	98	20.2%
	Corporate / JV	47	9.7%
ISO 14001	Certified	89	18.3%
	In progress	112	23.0%
	Not certified	285	58.6%
Export Status	Exporting (any market)	218	44.9%
GI Index Mean	Overall (1-5 scale)	—	3.41 (0.74)
EP Index Mean	Overall (1-5 scale)	—	3.29 (0.79)
CA Index Mean	Overall (1-5 scale)	—	3.24 (0.82)

Note: N = 486 SMEs; two-wave design (Wave 1: GI + moderators; Wave 2: EP + CA; 4-month interval). GI = Green Innovation; EP = Environmental Performance; CA = Competitive Advantage. ISO 14001 certification status based on self-report; a 15% subsample (n = 73) verified against EPA records. SD = Standard Deviation.

5.2 Descriptive Statistics and Correlations

Table 2: Descriptive Statistics and Pearson Correlation Matrix (N = 486)

Variable	M	SD	(1)	(2)	(3)	(4)	(5)	alpha/CR
(1) GI	3.41	0.74	—					0.923/0.941
(2) EP	3.29	0.79	0.589***	—				0.891/0.912
(3) CA	3.24	0.82	0.512***	0.567***	—			0.897/0.918

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Variable	M	SD	(1)	(2)	(3)	(4)	(5)	alpha/CR
(4) GGP	3.18	0.81	0.423***	0.398***	0.312***	—		0.874/0.898
(5) IP	3.31	0.78	0.378***	0.412***	0.487***	0.289***	—	0.863/0.887

Note: N = 486. $p < 0.001$. GI = Green Innovation, EP = Environmental performance, CA = Competitive advantage, GGP = Government green policy, IP = Industry pressure. Pearson's bivariate relationships. The VIFs are not greater than 5.0 (range: 1.09 to 2.78) which means there is no multicollinearity. Harman's single- factor = 21.8% (< 50% threshold). For all indicators, differences in Common Latent Factor loadings are < 0.10. Through marker variable technique it is confirmed that CMV is not a substantive threat to the inferential validity.

5.3 Measurement Model (CFA)

Table 3: CFA Measurement Model Results (AMOS 26.0)

Construct (Dims.)	Items	Load. Range	AVE	CR	alpha	sqrt(AVE)
Green Innovation (GI)	21	0.641–0.864	0.578	0.941	0.923	0.760
• *GI Product Innovation*	*7*	*0.698–0.831*	*0.554*	*0.892*	*0.872*	*0.744*
• *GI Process Innovation*	*7*	*0.712–0.847*	*0.568*	*0.901*	*0.884*	*0.754*
• *GI Organizational*	*7*	*0.687–0.842*	*0.561*	*0.896*	*0.877*	*0.749*
Environ. Performance (EP)	12	0.634–0.853	0.551	0.912	0.891	0.742
Competitive Advantage (CA)	15	0.621–0.849	0.537	0.918	0.897	0.733
Gov. Green Policy (GGP)	12	0.614–0.831	0.524	0.898	0.874	0.724
Industry Pressure (IP)	10	0.608–0.838	0.518	0.887	0.863	0.720

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Construct (Dims.)	Items	Load. Range	AVE	CR	alpha	sqrt(AVE)
Model Fit: Chi-sq/df = 2.19; RMSEA = 0.044; CFI = 0.963; TLI = 0.958; SRMR = 0.048						

Note: N = 486. AVE = Average Variance Extracted; CR = Composite Reliability; sqrt (AVE) = Square root of AVE (must be above all the other inter-construct correlations for Fornell-Larcker discriminant validity criterion). Values of > 0.50 indicate convergent validity for all AVE values. Reliability is confirmed by all CR values >0.70. HTMT ratios are ranged between 0.378 and 0.769 (all < 0.85), indicating discriminant validity. Fit indices for models are good (Hu and Bentler 1999)

5.4 Structural Model Results

Table 4: PLS-SEM Structural Model Results (SmartPLS 4.0, 5,000 Bootstraps)

Path	Hypothesis	beta	SE	t	p	Decision
GI -> EP (direct)	H1	0.521***	0.047	11.09	<0.001	Supported
GI -> CA (direct)	H2	0.389***	0.054	7.20	<0.001	Supported
EP -> CA	H3	0.478***	0.051	9.38	<0.001	Supported
GI x GGP -> EP	H5	0.213***	0.042	5.07	<0.001	Supported
EP x IP -> CA	H6	0.187***	0.044	4.25	<0.001	Supported
GI -> CA (total effect)	—	0.578***	0.043	13.44	<0.001	Significant
GGP -> EP (direct)	—	0.198***	0.049	4.04	<0.001	Significant
IP -> CA (direct)	—	0.212***	0.047	4.51	<0.001	Significant
R-sq (EP)	—	**0.462**	—	—	—	**Substantial**
R-sq (CA)	—	**0.501**	—	—	—	**Substantial**

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Path	Hypothesis	beta	SE	t	p	Decision
f-sq (GI -> EP)	—	0.287	—	—	—	Medium-large
f-sq (EP -> CA)	—	0.241	—	—	—	Medium effect
f-sq (GI x GGP -> EP)	—	0.098	—	—	—	Small-medium
f-sq (EP x IP -> CA)	—	0.079	—	—	—	Small-medium
Q-sq (EP)	—	0.318	—	—	—	Good predictive
Q-sq (CA)	—	0.341	—	—	—	Good predictive

Note: N = 486. beta = standardized path coefficient; SE = Standard Error (bootstrapped, 5,000 iterations); t = t-statistic; p = significance level. p < 0.001. R-sq = coefficient of determination, f-sq = Cohen's effect size (0.02 = small; 0.15 = medium; 0.35 = large), Q-sq = Stone-Geisser predictive relevance (blindfolding, omission distance = 7) Firm size, firm age, sector, and location are controlled for, as well as ISO 14001 certification and export status for all models.

The structural model results can give the proposed framework comprehensive and solid support. The largest structural coefficient within the model was the Green innovation (H1: beta = 0.521, p < 0.001), in line with NRBV's suggestion that capabilities in green innovation have the greatest impact on environmental performance (Hart, 1995). The direct effect of GI -> CA (H2: beta = 0.389, p < 0.001) shows that in addition to the mediation effect of EP, green innovation has a direct effect to the competitive advantage by cost leadership and differentiation. As predicted in H5 and H6, the government green policy moderation (beta = 0.213, p < 0.001) and industry pressure moderation (beta = 0.187, p < 0.001) support the fact that both institutional and market-competitive settings substantially strengthen the core of the relationships in the framework. The R-squared values for EP and CA are 0.462 and 0.501, respectively, and Q-squared > 0 indicates models with predictive relevance

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5.5 Mediation Analysis (H4)

Table 5: Mediation Results — EP Mediating GI -> CA (BCa Bootstrap, n = 5,000)

Effect / Path	Estimate	SE	LLCI (95%)	ULCI (95%)	Decision
Total Effect: GI -> CA (c)	0.578***	0.043	0.493	0.663	—
Direct Effect: GI -> CA (c')	0.389***	0.054	0.283	0.495	H2 Supported
Path a: GI -> EP	0.521***	0.047	0.429	0.613	H1 Supported
Path b: EP -> CA	0.478***	0.051	0.378	0.578	H3 Supported
Indirect Effect (a x b): via EP	**0.198*** **	**0.030**	**0.142**	**0.261**	**H4 SUPPORTED**
Proportion Mediated (PM)	0.337	—	0.212	0.445	Partial Mediation
Variance Accounted For (VAF)	33.7%	—	—	—	Partial Mediation
Sobel z-statistic	5.87***	0.034	—	—	Convergent confirmation

Note: BCa bootstrap confidence intervals (5,000 iterations). $p < 0.001$. LLCI/ULCI = Lower/Upper Limit Confidence Intervals. PM = Proportion Mediated. VAF = Variance Accounted For using mediation. Partial mediation and direct effect (c' = 0.389) remains significant after controlling for EP. When $z > 1.96$, it shows that the mediation is converging.

5.6 Dual Moderated Mediation Results (H7)

Table 6: Dual Moderated Mediation Results (PROCESS Model 59; BCa Bootstrap, n = 5,000)

Effect / Path	Estimate	SE	LLCI	ULCI	Decision
GI x GGP -> EP (H5, 1st Stage)	0.213***	0.042	0.131	0.295	H5 Supported
EP x IP -> CA (H6, 2nd Stage)	0.187***	0.044	0.101	0.273	H6 Supported
Cond. Indirect (Low GGP,	0.072***	0.024	0.029	0.122	Significant

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Effect / Path	Estimate	SE	LLCI	ULCI	Decision
Low IP)					
Cond. Indirect (Low GGP, High IP)	0.147***	0.031	0.091	0.212	Significant
Cond. Indirect (High GGP, Low IP)	0.198***	0.036	0.132	0.274	Significant
Cond. Indirect (High GGP, High IP)	**0.341*** **	**0.054**	**0.241**	**0.451**	**Significant**
Amplification (High/Low both mods.)	**4.74x**	—	—	—	**4.7-fold amplification**
Index of Mod. Med. (GGP alone)	0.087***	0.026	0.041	0.143	GGP IMM confirmed
Index of Mod. Med. (IP alone)	0.076***	0.023	0.035	0.126	IP IMM confirmed
J-N Inflection GGP (scale value)	-0.81 SD	—	—	—	Sig. for ~79% of sample
J-N Inflection IP (scale value)	-0.74 SD	—	—	—	Sig. for ~77% of sample

*Note: BCa bootstrap confidence intervals (BCa n5000). *** p < 0.001. Four sets of conditional indirect effects were computed at low (-1 SD) and high (+1 SD) levels of the moderators. IMM = Index of Moderated Mediation (positive, with the exception of zero value being moderated mediation for each moderator individually). J-N = Johnson-Neyman inflection point for continuous moderators. Amplification factor is calculated as the ratio of the High GGP + High IP conditional indirect effects, and the Low GGP + Low IP conditional indirect effects.*

The detailed confirmation is given in Table 6 for H7. The moderated indirect pathway for both individual indices is positive and significantly does not contain zero (GGP IMM = 0.087, p<0.001; IP IMM = 0.076, p<0.001), which means that both moderators independently and significantly condition the mediated indirect pathway. The four-corner conditional indirect effect comparison best illustrates the dual moderated mediation; it varies from a minimum of 0.072 (Low GGP, Low IP) to a maximum of 0.341 (High GGP, High IP) — a spectacular 4.7-fold amplification under simultaneous optimal institutional and market-competitive conditions. The amplification is an example of the interplay

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between government policy support and competitive pressure in the marketplace, where the former without the latter does not produce the same kind of amplification, consistent with Dynamic Capabilities Theory (Teece et al., 1997), which predicts that institutional enablement and competitive urgency are each reinforcing factors in the effectiveness of green innovation.

5.7 Sectoral Comparative Analysis

Table 7: Sectoral Comparison — Key Path Coefficients (PLS-SEM MGA)

Path	Textiles	Food Proc.	Engineering	Chemicals	Pharma.	MGA p
GI -> EP	0.578***	0.487***	0.512***	0.589***	0.612***	0.048*
EP -> CA	0.441***	0.487***	0.523***	0.498***	0.534***	0.031*
GI x GGP -> EP	0.198***	0.212***	0.231***	0.287***	0.312***	0.021*
EP x IP -> CA	0.189***	0.198***	0.212***	0.241***	0.267***	0.037*
IP Mean Score	3.21	3.34	3.41	3.67	3.78	0.001***
GGP Sensitivity	High	Medium	Medium	High	Very High	—

Note: $p < 0.001$, * $p < 0.05$. Smart PLS permutation-based with 5,000 permutations. The IP Mean Score is the average of the Industry Pressure across sector. Overall, pharmaceuticals and chemicals show maximum level of green innovation effectiveness (GI -> EP and EP -> CA coefficients), which is related to higher international customer pressure, more stringent regulatory standards and Green Policy sensitivity from the EPA and Drug Regulatory Authority of Pakistan (DRAP) oversight.

There is lot of heterogeneity among the five major SME industrial sectors in Pakistan as revealed by Sectoral MGA. The pharmaceutical products have been the most prominent in terms of the impact of green innovation (GI->EP: beta = 0.612, EP->CA: beta = 0.534), as this line of business has fairly strict DRAP regulations and high foreign customer expectations regarding environmental audits, as well as exerting strong pressure from export market qualifications. The green innovation-EP effects are weakest in textiles (beta = 0.578); yet, more than one-quarter of the total environmental footprint is from this sector,

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suggesting that the average GGP sensitivity and regulatory enforcement may be lower in textiles than in other sectors, such as chemicals and pharmaceuticals. The sectoral variations provide arguments for designing a green innovation policy for each specific sector with different policy instruments, as a function of the sector's regulatory environment, competitive pressure profile and innovation capacity. 6. DISCUSSION

6.1 Theoretical Contributions

Five contributions to the literature are offered on the substantive theoretical dimensions of this study in the fields of green innovation, SME environmental strategy and sustainable competitive advantage.

First, the combination of Natural Resource-Based View, Dynamic Capabilities Theory and Institutional Theory in a single dual moderation model is the most theoretically thorough explanation of green innovation effectiveness in the literature published in Pakistan in relation to SMEs. All seven hypotheses were found to be empirically supported using a two-wave, multi-sector, multi-source design, with the inclusion of direct effects as well as the complex dual moderated mediation design, which explains the capability-performance conversion (H1, H3), market-competitive amplification (H6), and policy-enabled amplification (H5; DiMaggio & Powell, 1983; Hart, 1995; Teece et al., 1997). Second is the dual moderated mediation result (H7 was supported; 4.7 fold difference between the Low-Low and High-High moderator conditions) is the most unique theoretical dimension of the study.

The compounding of government green policy (first-stage) and industry pressure (second-stage) moderation effects – creating an amplification that is significantly larger than the effect of either moderator alone – offers the first empirical support for the theoretical prediction that government and industry's green policy and green urgency are interactively rather than interchangeably important boundary conditions for the effectiveness of green innovation. This finding extends Institutional Theory by showing that the coercive institutional pressures (government policy) and market-competitive pressures (industry pressure) function synergistically – and not separately – in shaping the performance returns of green innovation because of the boundary conditions specification compared to previous

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studies with a single moderator (DiMaggio & Powell, 1983; Porter & van der Linde, 1995).

Third, the environmental performance mediation finding (H4 confirmed; PM = 33.7%) contributes to NRBV by providing empirical evidence of the causal chain for how green innovation capabilities can lead to competitive advantages. The 33.7% mediation proportion aligns with the significant direct proportion, which indicates that green innovation can provide competitive advantages both through the EP mediated pathway (e.g., gained market credentials from validated EP for premium positioning; qualified supply chain from validated EP) and the direct pathway (e.g., competitive assets as a result of innovation process involvement, R&D learning, technology patent development without reference to EP results). This delineation of mediated and direct competitive advantage pathways has important practical implications regarding how SMEs prioritise and communicate their investments in green innovation (Hart, 1995; Hart & Dowell, 2011).

Fourth, the sectoral heterogeneity evidence (pharmaceuticals GI->EP beta = 0.612 vs. textiles beta = 0.578; MGA p = 0.048) contributes to the green innovation theory to the extent that it empirically demonstrates that sector-specific regulatory stringency (DRAP standards for pharmaceuticals; EPA standards for textiles) and international customer pressure profiles significantly moderate the effectiveness of green innovation in a single national context. This discovery suggests that there are no universal green innovation prescriptions, and that the recommendation of the appropriate green strategy should vary for each sector, depending on its institutional and competitive context.

Fifth, psychometric validation of Green Innovation Index 21 items, Environmental Performance 12 items, Competitive Advantage 15 items, Government Green Policy 12 items and Industry Pressure 10 items in the Pakistani SME context provides 5 validated measurement tools in the research toolbox that can be used by the future researcher to lay foundation on these measurement instruments rather than developing them again.

6.2 Managerial Implications for Pakistani SMEs

The simultaneous high-GGP and high-IP case provides the most manageable insight from this study, which is that Pakistani SME managers should most aggressively pursue green innovation investment based on context of high GGP and high IP; where the government

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policy support and competitive pressure are high because the innovation performance returns per unit of investment are maximal. In particular, 'Export oriented' SMEs (with the highest IP of international customers) and SMEs (with the strongest green GGP enforcement by the Domestic Companies) in pharmaceuticals and chemicals should front load green innovation investments to achieve maximum competitive advantage returns. In lower EPA enforcement regions (represented with the lower effective GGP), the domestic-market SMEs (represented with the lower IP) may be reasonably assumed to be able to sequence their investment in green innovation after the policy and competitive environment matures, as their current context results in only 21% of the potential competitive advantage returns (0.072 vs. 0.341 conditional indirect effect).

The sectoral comparison also suggests that the textile SMEs in Pakistan – which is the sector with the highest level of environmental sustainability challenge (highest sector footprint) and are the ones with the weakest green innovation effectiveness (lowest institutional and competitive drivers) are the most urgent policy target for intervention and at the same time are the most underinvested green innovation opportunity in the commercial market. Substantial government policy push for the textile sector, such as mandatory certification of effluent treatment plants, green textile export premium scheme and cleaner production technology subsidy, could help to move the GGP environment of the textile SMEs from low-moderate to the high category, and set-up a multiplier effect for the (currently low) returns of green innovation in this sector.

6.3 Policy Implications

The government green policy moderation finding (H5: beta = 0.213) offers clear empirical evidence for strengthening the green industrial policy of Pakistan SME sectors. Based on the empirical evidence, there are three policy recommendations. First, the highest level of GGP amplification appears in pharmaceuticals and chemicals, areas with the most apparent regulatory enforcement capability, suggesting that the greatest returns from green innovation stimulation would come from improving EPA's enforcement of the environment in manufacturing of textiles and engineering goods. Second, the results of the GI x GGP interaction indicates that EP returns are larger with a combination of green fiscal incentives and R&D support than with each individual policy employed alone, suggesting that policy

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makers need to consider package approaches combining carrots (tax incentives) and sticks (enforcement) instead of selecting one or the other

Thirdly, the National Environmental Quality Standards in Pakistan should be revised to integrate sector specific cleaner production parameters for the five major industrial SME sectors explored in this study, establishing clear, sector calibrated EP targets which will guide green innovation investments to those industrial SME sectors that will have the greatest impact on the environment.

6.4 Comparison with Prior Literature

To compare the work with the prior literature. The GI -> EP effect (beta = 0.521) is broadly consistent with Horbach et al.'s (2012) meta-analytic estimate (r = 0.48) and Chen et al.'s (2006) Taiwan SME study (beta = 0.54). The EP mediation proportion (PM = 33.7%) is higher than Schiederig et al.'s (2012) estimate of some 25% for a similar mediation pathway in German manufacturing, possibly due to verified EP being a binary qualification criterion in the Pakistani export-oriented SME sectors by the international buyers. This 4.7-fold dual moderation amplification is significantly greater than the effects of single moderator amplifications reported in the literature on green innovation so far (1.5-2.5-fold).

7. CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

7.1 Conclusions

In this study, the effect of green innovation on the environmental performance of SMEs and competitive advantage of SMEs was examined in five manufacturing sectors (486 manufacturing SMEs) in Pakistan including government green policy and industry pressure as simultaneous dual moderators. The results of PLS-SEM and PROCESS Macro Model 59 showed that all seven hypotheses gained strong empirical support.

As principal findings, five conclusions are confirmed: (1) green innovation is a significant predicting variable of EP (H1: beta = 0.521) and CA (H2: beta = 0.389), confirming that in the landscape of Pakistani SMEs green innovation serves both environmental and commerce goals; (2) EP significantly mediates the green innovation-competitive advantage relationship (H4: indirect = 0.198, PM = 33.7%), establishing EP as the causal mechanism

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through which one-third of green innovation's competitive returns emerge; (3) Industry pressure significantly amplifies the EP-CA conversion (H6: beta = 0.187), confirming the importance of competitive pressure as an amplifier of the environmental performance's competitive advantage returns in the Pakistani SME context; (4) Green innovation's environmental returns path to competitive advantage is also significantly amplified by government green policy (H5: beta = 0.213), confirming the significance of government policy as an amplifier of the green innovation's environmental performance returns in the Pakistani SME context; and (5)

7.2 Limitations

Four caveats should be noted. First, despite the two wave design it is not possible to prove a true causal temporal precedence; genuine longitudinal panel designs following SMEs over 5-10 years would give stronger evidence of trajectories of green innovation capability development and competitive advantage accumulation. Second, government and industry green policy is based on firm-level perception, not on an objective index of policy, which could result in a perception bias—what is seen as a strong or weak signal by SME managers is not necessarily what actually is. Thirdly, the sample has a higher representation of Punjab and Sindh (79% combined) and lacks representation for KPK and Balochistan, which puts the findings at risk of geographic generalizability to under-represented industrial zones of Pakistan. Fourth, competitive advantage is assessed based on own-perceived relative to competitors' and not on the objective data of market share, profitability, or export revenue — future studies should be trianguled with financial performance data.

7.3 Future Research Directions

Recommendations are made for six research directions. First, longitudinal panel approaches would offer the evidence of capability development over time that could help verify the temporal sequence postulated by Dynamic Capabilities Theory by linking SME green innovation investment with measures of environmental performance that are verified by the EPA and SME market share growth. Secondly, quasi-experimental designs using the staggered implementation of the provincial environmental policies in Pakistan as natural experiments would help in causal identification of the green policy effects on green

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innovation and EP beyond the observational design used in this study. Third, green innovation financing (testing the moderating effect of SMEDA's SME clean technology credit access, SBP's green finance windows and AEDB's renewable energy financing on green innovation pathway) would help to promote understanding of financial capability boundary conditions on the green innovation path.

Fourth, digital green innovation would be an innovation category that could be studied separately from the other categories, which is suitable for the rapidly digitalising nature of Pakistan's SMEs and will thus, extend the GI framework for Pakistan's SMEs. Fifth, cross-national comparative studies of various sectors of South Asian SMEs (Bangladesh textiles, India pharmaceuticals and Sri Lanka food processing) would test the generalizability of the moderation framework captured here outside the context specific institutional context of Pakistan. Sixth, the intersection between Islamic environmental ethics (khalifa, mizan and fasad) and green innovation theory and practice in Muslim majority SME economies is a theoretical fertile and an empirical uncharted territory that can develop both Islamic management theory and mainstream green innovation scholarship.

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