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

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Green process innovation and financial performance in small and medium-sized enterprises in a developing Country: Role of resource orchestration

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ABSTRACT

While existing resource-based theorizations consider green process innovation as an important internal firm resource, this research utilizes the resource orchestration logic to argue that a greater capability to manage and deploy green process innovation is a major contributor to financial performance of small and medium-sized enterprises (SMEs). The study posits that conditions of high green value co-creation, supported by a robust customer-driven green strategy, enable SMEs to orchestrate green process innovation to improve financial performance. The study tests these arguments on primary data from 224 manufacturing SMEs in a developing country in Sub-Saharan Africa – Ghana. The results support the study's theorizations. However, the study also finds that high green value co-creation, when supported with less emphasis on customer-driven green strategy, amplifies the financial benefits SMEs generate from green process innovation. These findings offer new insights into the resource orchestration conditions under which investments in green process innovation pay off.

1. Introduction

As industrial activities intensify and stakeholders increase pressure on firms to curb environmental footprints, the adoption of green process innovation to balance environmental sustainability with economic benefits continues to attract the attention of scholars and business leaders (Xu et al., 2023; Bureau Van Dijk, 2022). A major contention is that green process innovation, defined as the extent to which firms use eco-friendly processes and methods in manufacturing activities, can improve efficiency and market performance while reducing the adverse impacts of manufacturing operations on the environment (Tariq et al., 2023; Bhatia, 2021). However, the literature also suggests that green process innovation can be a double-edged sword as it is resource-intensive (Xie et al., 2019) and may overshadow and conflict with other strategic priorities while undermining existing core competencies

(Opazo-Basáez et al., 2024; Zhang et al., 2020). An argument, therefore, is that under conditions of resource scarcity and in situations where motivation for green process innovation is low, as is often the case in small and medium enterprises (SMEs) in developing countries (Bureau Van Dijk, 2022), business executives are concerned about whether and when investment in green process innovation pays off (Tariq et al., 2023; Xie et al., 2019).

These concerns have spurred a growing body of research on how and the conditions under which investment in green process innovation financially benefits SMEs. While most past studies suggest that firms benefit from investment in green process innovation (e.g., Achi et al., 2022; Qing et al., 2022), others indicate otherwise (e.g., Xie et al., 2022; Yao et al., 2019), suggesting that important contingencies may condition the extent to which green process innovation generates financial benefit for firms. For example, as detailed in Table 1, evidence from prior

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Table 1
Evidence on the green process innovation – performance link: A comparison between past studies and this study.

Author(s) (year)	Independent variable (s)	Moderating variable (s)	Dependent variable(s)	Theoretical and empirical approaches	Empirical setting and data type	Country context: Developed vs emerging/developing	Key finding(s)
Opazo-Basáez et al. (2024)	Organizational performance (efficiency)	Green process innovation	Environmental performance	Natural resource-based view Two-way interaction analysis	Medium-sized manufacturing firms in Spain Survey data provided by senior /middle managers in 354 firms	Developed country	Green process innovation has a positive relationship with environmental performance. The interaction between green process innovation and efficiency performance positively affects environmental performance.
Tariq et al. (2023)	Green process innovation performance	Slack resources Competitive intensity	Financial risk	Natural resource-based view Main effect and two-way interaction analysis	Listed manufacturing firms in Thailand. Survey data provided by senior and middle-level managers, combined with secondary data from 202 firms	Emerging/developing country	Green process innovation performance negatively affects financial risk. This relationship amplifies and weakens under increasing competitive intensity conditions and decreasing slack resource conditions, respectively.
Achi et al. (2022)	Green process innovation	Perceived environmental volatility	Firm (financial) performance	Dynamic capabilities theory Main effect and two-way interaction analysis	Micro, small, and medium-sized enterprises in a Nigeria Survey data provided by senior managers in 176 firms	Emerging/developing country	Green process innovation has a positive relationship with firm performance. This relationship weakens under high conditions of perceived environmental volatility.
Xie et al. (2022)	Green process innovation	Green social capital Green needs' tacitness	Financial performance	Resource-based view Two-way curvilinear analyses	Manufacturing firms in China Survey data provided by managers/ technical supervisors in 221 firms	Emerging/developing country	Green process innovation has a U-shaped relationship with financial performance. Green social capital and green needs' tacitness tend to weaken and apply this relationship, respectively.
Qing et al. (2022)	Proactive green process innovation	Absorptive capacity (R&D intensity)	Short-term financial performance Long-term financial performance	Resource-based view Main effect and two-way interaction analyses	Secondary sourced panel data from 126 listed companies in China	Emerging/developing country	Proactive green process innovation positively affects both short-term and long-term financial performance. These effects are stronger for firms with high absorptive capacity.
Wang et al. (2021)	Green process innovation		Green production innovation Environmental performance Market competitiveness Economic (financial) performance	Resource-based theory, institutional theory, and stakeholder theory Main and indirect effect analysis	Industrial enterprises in China Survey data provided by senior managers in 642 firms	Emerging/developing country	Green process innovation positively affects green product innovation, environmental performance, market competitiveness, and economic performance. Environmental and market competitiveness mediate the relationship between green process innovation and economic performance.
Bhatia (2021)	Green process innovation		Technological capability Organizational learning Operational performance	Dynamic capabilities theory	Survey data provided by top, middle, and lower-level managers in 137 firms.	Undefined	Green process innovation positively relates to technological capability and organizational learning and unrelated to operational performance. Technological capability or organizational learning positively mediates the relationship between green process innovation and operational performance.
Xie et al. (2019)	Green process innovation		Green product innovation Financial performance	Resource-based theory, institutional theory, and stakeholder theory	209 listed manufacturing firms in China Secondary/archival data	Emerging/developing country	Green process innovation positively affects green product innovation and financial performance. Green product innovation positively mediates the

(continued on next page)

Table 1 (continued)

Author(s) (year)	Independent variable (s)	Moderating variable (s)	Dependent variable(s)	Theoretical and empirical approaches	Empirical setting and data type	Country context: Developed vs emerging/ developing	Key finding(s)
Yao et al. (2019)	Eco-process innovation	Institutional pressures: regulation intensity, environmental agency pressure, and public pressure	Firm value	Institutional theory Main and two- way interaction effect analyses	Cross-sectional panel data from listed manufacturing companies in China	Emerging/ developing country	relationship between green process innovation and financial performance, especially when green image is high. Eco-process innovation has a negative effect on firm value. This effect is weaker under high conditions of regulatory intensity or environmental agency pressure.
Xie et al. (2016)	Clean technologies End-of-pipe technologies,	Absorptive capacity (R&D expense) Green subsidies	Financial performance	(Natural) resource-based theory Main effect and two-way interaction analyses	10-year industry-level panel data from 28 manufacturing industries in China Secondary data	Emerging/ developing country	Clean and end-of-pipe technologies positively affect financial performance. Absorptive capacity strengthens the contribution of clean technologies to financial performance. Green subsidies weaken the contribution of end-of-pipe technologies to financial performance.
This research	Green process innovation	Green value co- creation Customer-driven green strategy	Financial performance	Resource orchestration theory Two and three- way interaction analyses	Small and medium- sized manufacturing firms in Ghana Survey data provided by top and middle- level managers in 224 firms	Emerging/ developing country	Green process innovation has a positive relationship with financial performance. This relationship amplifies under increasing conditions of green value co-creation, especially when customer driven green strategy is low or high. The relationship weakens when both green value co- creation and customer- driven green strategy take on low values.

research highlights major contingencies, such as competitive intensity, slack resources (Tariq et al., 2023), perceived environmental volatility (Achi et al., 2022), green social capital, and green needs tacitness (Xie et al., 2022), that explain the boundary conditions of the relationship between green process innovation and financial performance. Consequently, recent studies have called for additional contingency-based research in specific settings (e.g., Tariq et al., 2023; Opazo-Basáez et al., 2024; Bhatia, 2021), especially underexplored developing countries, to explain when green process innovation financially benefits firms (Achi et al., 2022; Khan et al., 2021). However, a major deficiency in the existing theorizations of green process innovation and its financial performance outcomes is the assumption that firms are equivalent in their ability to manage and leverage green process innovation successfully. Besides, prior contingency-based theorizations and empirical analyses assume that the contingencies that characterize the green process innovation–financial performance relationship are independent, offering reductionist insights into the boundary conditions of the relationship (Flynn et al., 2010). This study develops and tests a new theoretical perspective to address these theoretical and empirical concerns.

The study draws insights from the resource orchestration literature (Sirmon et al., 2011; Sirmon et al., 2007) to contend that while green process innovation is inherently valuable (Khan et al., 2021; Tariq et al., 2023), its contribution to financial performance is contingent upon firms’ ability to acquire, manage, and deploy it in a cost-effective manner (Sirmon & Hitt, 2009; Sirmon et al., 2011). Thus, this study proposes green value co-creation as a major knowledge-based competence that enables firms to orchestrate green process innovation cost-effectively (Schweiger et al., 2019), especially when pursuing a

market-linking strategy such as a customer-driven green strategy (Sirmon et al., 2011). Green value co-creation refers to the extent to which a firm involves and collaborates with external actors in green innovation activities (Tian et al., 2022). In contrast, customer-driven green strategy refers to the extent to which a firm’s green innovation activities respond to customer expectations and requirements (Nguyen et al., 2020). This study develops and tests the argument that green value co-creation, individually and in combination with customer-driven green strategy, strengthens the contribution of green process innovation to financial performance in SMEs in a developing country.

The study, therefore, addresses the question: *how does green value co-creation moderate the relationship between green process innovation and financial performance under varying conditions of customer-driven green strategy?* The study provides two major theoretical contributions and one important contextual contribution to the green process innovation literature. First, the study reveals that accounting for the interactions between multiple organizational contingencies offers finer insights into the relationship between green process innovation and financial performance. Second, the study uses the resource orchestration perspective to provide a novel approach to theorizing about the boundary conditions of the relationship between green process innovation and financial performance. Contextually, this study pushes the boundaries of green process innovation research by studying the construct in a challenging, overlooked, and under-researched context of SMEs in a Sub-Saharan African country (i.e., Ghana), thus helping to broaden the diversity of empirical evidence and extend the utility of theory on green progress innovation.

2. Theoretical Background and Hypothesis development

2.1. Green process innovation and financial performance

The notion of green process innovation emerges from the literature on the interface between innovation and environmental management, and it has been argued as an extension of the generic process innovation concept (Cherrafi et al., 2018; Khan et al., 2021). Process innovation refers to “new elements (e.g. new production methods, management approaches and new technologies) introduced into organizations’ management and production operations” (Cherrafi et al., 2018, p. 82). As a specific form of process innovation, green process innovation involves “modifying manufacturing systems and processes in order to reduce environmental impacts, pollution, and other negative effects on the use of resources” (Cherrafi et al., 2018, p. 82). Other scholars describe green process innovation as the modification or introduction of new production processes or cleaner technologies that prioritize efficient resource use and pollution reduction through environmentally friendly practices such as recycling and material substitution (Lisi et al., 2020; Qiu & Wang, 2020; Xie et al., 2016). While process innovations are traditionally motivated by economic goals (Piening and Salge, 2015), green process innovation focuses on environmental protection, although it presents opportunities for firms to generate economic benefits (Khan et al., 2021; Cherrafi et al., 2018).

Extant literature suggests green process innovation enhances energy and cost efficiency, reduces waste, and maximizes resource utilization (Xie et al., 2019). It is further suggested that green process innovation enables firms to create safer work environments, minimize environmental fines, and develop differentiated eco-friendly products that appeal to environmentally conscious consumers to gain market advantage (Qiu & Wang, 2020; Xie et al., 2019; Wang et al., 2021). Accordingly, some studies indicate that green process innovation provides financial benefits to firms (e.g., Achi et al., 2022; Qing et al., 2022). However, other studies indicate otherwise (e.g., Xie et al., 2022; Yao et al., 2019), suggesting that the contribution of green process innovation to financial performance may not be uniform across all contexts (Tariq et al., 2023).

Accordingly, past studies have shed light on some contextual factors that moderate the relationship between green process innovation and financial performance (see Table 1). Thematically, such contextual factors include firms’ ability to develop green processes (Tariq et al., 2023; Xie et al., 2016), adopt efficient and effective approaches to the development of green processes (Xie et al., 2022; Xie et al., 2016), access complementary resources (Opazo-Basáez et al., 2024; Xie et al., 2016), promote green initiatives (Xie et al., 2019), and the extent to which the external environment either hinders or supports acquisition of resources for green process innovation (Tariq et al., 2023; Achi et al., 2022; Yao et al., 2019). While these prior studies offer useful insights on the boundary conditions of the relationship between green process innovation and financial performance, their propensity to use a reductionist approach to examine the moderators in isolation means that knowledge is lacking on the complexity of the boundaries of the relationship. This study addresses this shortcoming by analyzing how green value co-creation combines with customer-driven green strategy to moderate the relationship between green process innovation and financial performance (see Fig. 1).

Although business leaders and environment policy makers continue to debate the benefits of innovation policy for a green economy in developing countries, there is currently limited research to inform business and policy decisions regarding the conditions under which green process innovation financially benefit SMEs in developing economies (Achi et al., 2022). Studies using SMEs in developing economies have primarily focused on China and other emerging Asian countries (Tariq et al., 2023; Khan et al., 2021). Yet, Sub-Saharan African countries are fraught with weak institutional and governance mechanisms for curbing environmentally unfriendly industrial activities (Shankar & Narang, 2020). While weak regulations combined with environmental

hostilities can encourage the symbolic adoption of green initiatives (Kumar & Srivastava, 2020), consumer markets in these countries have limited green awareness (Achi et al., 2022; Khan et al., 2021). The challenges associated with adopting and extracting financial benefits from green process innovation may be more significant in these countries, especially for SMEs (Shankar & Narang, 2020; Achi et al., 2022). Thus, by drawing on resource orchestration theory, this study argues that SMEs in developing economies require appropriate knowledge-based competencies and market-focused strategies that enable a cost-effective orchestration of green process innovation to drive financial performance (Sirmon et al., 2011).

2.2. The resource orchestration perspective

Scholars have drawn insights from various strands of the resource-based theory, including the resource-based view (Wang et al., 2021; Xie et al., 2016; Xie et al., 2019; Khanra et al., 2022), the natural resource-based view (Opazo-Basáez et al., 2024; Tariq et al., 2023), and the dynamic capability theory (Achi et al., 2022; Bhatia, 2021), to suggest that green process innovation is a valuable, rare, and costly-to-acquire firm resource. The central thesis in this body of work is that firms with greater green process innovation are better positioned to gain superior cost and differentiation advantages as they can rapidly and effectively adapt to changing market requirements for eco-friendly products and services (Achi et al., 2022; Bhatia, 2021). Green process innovation’s rarity and costly-to-acquire nature can be significant in resource-constrained settings. Therefore, this literature generally predicts that developing country SMEs with a greater green process innovation are likely to benefit more financially. However, in focusing on resource possession and control, the theoretical expectation of the resource-based views ignores the potential differences in firms’ ability to manage and exploit green process innovation resources for financial gains (Schweiger et al., 2019; Menguc et al., 2014).

Resource orchestration theory addresses such a deficiency by contending that possessing green process innovation alone does not guarantee superior performance; instead, the financial benefits of green process innovation are realized *when* firms manage green innovation activities in a cost-effective manner (Sirmon et al., 2011). The contention is that firms may differ in their ability to undertake resource management functions, including the capability to structure a portfolio of resources through resource acquisition, accumulation, and divestment; the ability to bundle resources to build other capabilities through stabilizing, enriching, and pioneering; and the competence to leverage existing capabilities through mobilization, coordination, and deployment to create and deliver superior market value (Sirmon et al., 2011).

This study argues that green value co-creation empowers firms to undertake these resource management functions pertaining to green process innovation, especially if supported by customer-driven green strategy. This conceptualization of green value co-creation as a resource orchestration competence is consistent with past studies that theorize knowledge-based strategic orientations (e.g., entrepreneurial orientation, market orientation, and learning orientation) as enabling tendencies that allow firms to engage in resource orchestration activities (Schweiger et al., 2019; Chirico et al., 2011). For example, Chirico et al. (2011) argue that entrepreneurial orientation (EO) “provides the mobilizing vision to use firm resources. By directing the use of resources, EO not only provides an objective, but also helps identify the resources necessary to support the objective” (p. 311). Relatedly, Schweiger et al. (2019) contend that market orientation “helps avoid technological myopia and streamlines a firm’s efforts toward relevant consumer market needs..., creating a platform for pioneering” (p. 1829).

2.3. Boundary condition role of green value co-creation

Consistent with the resource orchestration perspective (Sirmon et al., 2011), therefore, this study defines and operationalizes financial

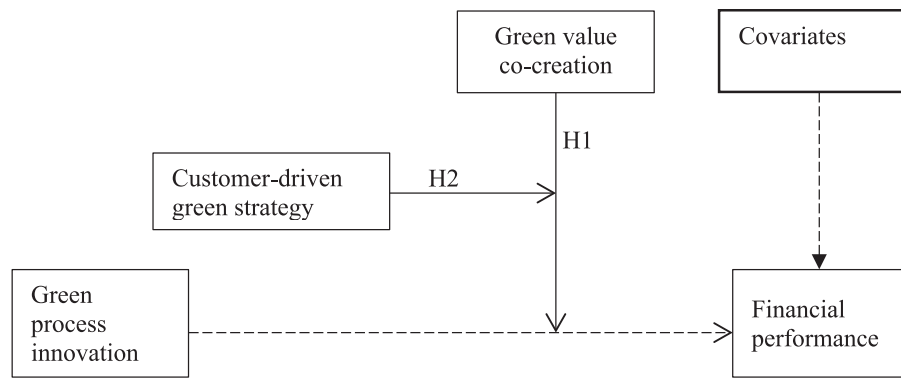


Fig. 1. Conceptual model. **Notes:** 1. Broken lines in the conceptual framework represent relationships examined in past studies as well as model covariates: environmental orientation, stakeholder pressure, proactive behavior, risk-taking behavior, technological turbulence, customer dynamism, firm size, and firm age. 2. Thick lines represent the hypothesized relationships theorized and tested in the current study.

performance as the degree to which a firm achieves financial objectives better than its competitors. The study contends that, while green process innovation has the potential to drive financial performance, several organizational contingencies can moderate its efficacy. For example, green process innovation may involve high investment costs and the need to transform existing manufacturing systems, potentially disrupting established core competencies and reducing efficiency. These concerns could lead to longer payback periods as investments in green process innovation increase (Holzner & Wagner, 2022; Xie et al., 2019). Importantly, the technologies and methods that underpin green process innovation are multifaceted and have varied cost implications and market benefits (Bureau Van Dijk, 2022; Xie et al., 2016). Accordingly, from a resource orchestration perspective (Schweiger et al., 2019), this study argues that green value co-creation can provide firms with strategic insights into building, structuring, and cost-effectively leveraging a portfolio of green technologies and methods to create and deliver superior market value (Sjödín, 2019; Menguc et al., 2014).

Extant literature indicates that economically rewarding innovations accrue when firms incorporate ideas and support from suppliers and customers through co-creation activities (Appiah, 2024; Cui & Wu, 2016). Green value co-creation reflects the degree to which firms actively exchange green ideas with suppliers and customers and involve them in production and consumption decisions (Tian et al., 2022). Green value co-creation can, therefore, help firms develop appropriate knowledge-based competencies for managing and extracting value from green initiatives, such as green process innovation (Tian et al., 2022; Chang, 2019). Generally, process innovation comes with significant challenges, which can overwhelm SMEs with limited appropriate knowledge resources for modifying existing manufacturing technologies and routines (Sjödín, 2019). Engaging suppliers can help SMEs tap into innovative ideas and, importantly, information and support for acquiring, accumulating, and adjusting green manufacturing technologies and processes that align with suppliers' requirements, capabilities, and materials (Kobarg et al., 2020; Hofman et al., 2020; Sjödín, 2019). Like suppliers, customers are important sources of innovative ideas for enriching green process innovation (Sjödín, 2019; Arnold, 2017). Involving and interacting with customers on green initiatives can help firms develop manufacturing systems and capabilities that boost their efficacy in producing products that the market requires and can pay for (Kobarg et al., 2020; Sjödín, 2019).

Supplier and customer expectations and requirements are constantly evolving. Therefore, co-creating value with suppliers and customers can assist firms in better determining the desirability and cost-effectiveness of green technologies at different times (Cui & Wu, 2016). It can further help identify which technologies should be phased out or upgraded and the extent of the necessary changes (Schweiger et al., 2019; Sirmon et al., 2011). Therefore, the resource orchestration perspective suggests

that ongoing interaction between firms and their supply chain partners provides valuable insights for aligning, coordinating, and mobilizing green technologies and methods that support the development of cost-effective products, enhancing firms' market advantage (Schweiger et al., 2019).

Additionally, it can be argued that an increased participation of suppliers and customers in green process innovation can enhance a company's market reputation and foster broader acceptance of its new green products (Tian et al., 2022; Menguc et al., 2014). With greater green value co-creation, firms can secure the support and buy-in of supply chain partners in the innovation process (Menguc et al., 2014). This, in turn, reduces the likelihood of waste, enhances goodwill, and attracts greater patronage from customers. These benefits can help firms fully exploit the inherent value associated with green process innovation to enhance financial performance (Pucci et al., 2020; Allal-Chérif et al., 2023). In sum, it can be expected that greater supplier and customer involvement in green initiatives may help reduce the drawbacks of green process innovation while amplifying its financial benefits.

Consistent with these arguments, Menguc et al. (2014) demonstrate that customer and supplier involvement complement incremental process innovation in enhancing the financial returns on new products. In contrast, prior research shows that when supply chain value co-creation is low, firms might acquire green technologies and methods that are expensive and incongruent with supply and demand market conditions and requirements (Tian et al., 2022). While such situations can increase the payback period of green process innovation, they may particularly limit firms' potential to exploit the market value of green process innovation.

This study recognizes that co-creation activities involving customers and suppliers present unique challenges and opportunities. Firms typically have fewer suppliers than customers. Relational complexity and associated costs increase with the number of actors in value co-creation activities, and there is a limit to the number of actors that firms can practically involve in green value co-creation. Thus, in relative terms, firms can engage more suppliers than customers, and broadening green value co-creation activities to include more customers can be less efficient. While the analysis of the green value co-creation construct in this study does not differentiate between customers and suppliers, the overarching theoretical arguments suggest that the involvement of suppliers and customers in green value co-creation can offer unique and complementary benefits that can amplify the contribution of green process innovation to financial performance. Accordingly, this study hypothesizes that:

Hypothesis 1. *Green value co-creation moderates the relationship between green process innovation and financial performance, such that the relationship is positive and stronger under greater conditions of green value co-creation.*

2.4. Boundary condition roles of green value co-creation and customer-driven strategy

A common assumption is that the market desires and rewards green innovations. However, the generality of this assumption may be questionable as customer green perception and preference differ across developed and developing countries (Rahman, 2023). We argue that customer-driven green strategy is necessary for determining the extent to which customers desire and are willing to pay for investment in manufacturing technologies and processes that produce environmentally friendly products. Implementing customer-driven green strategy is particularly important in developing countries as green awareness is still limited (Appiah & Essuman, 2024). In developing countries, customer-driven green strategy can help firms pursue more measured green initiatives, especially if supported by green value co-creation (Shankar & Narang, 2020).

The manufacturing strategy literature suggests that market-based strategies inform operations capability development and deployment activities (Alves Filho et al., 2015; Peng et al., 2011). The seminal work by Skinner (1969) highlights how a misalignment between market requirements and manufacturing technologies undermines operational efficiency and market performance. Consistent with this literature, resource orchestration theory suggests that market strategies, such as differentiation strategy, interact with and reinforce resource orchestration activities to drive competitive advantage (Sirmon et al., 2011). The argument is that market strategies guide resource structuring, bundling, and deployment, whereas these resource orchestration processes are necessary to implement these strategies effectively (Sirmon et al., 2011). Accordingly, in extending Hypothesis 1, this study suggests that customer-driven green strategy interacts with green value co-creation to enhance the contribution of green process innovation to financial performance in a developing economy context.

Customer-driven green strategy refers to the extent to which a firm's green innovation activities respond to customer expectations and requirements (Nguyen et al., 2020). While both customer-driven green strategy and green value co-creation prioritize the voice of the customer and can offer complementary benefits (Schweiger et al., 2019), the former provides a reference frame within which the latter occurs. As Teece (2014) stresses, capability development should be aligned with and supported by an appropriate strategy to generate sustained financial success. Following the manufacturing strategy literature on capability development and utilization, this study proposes customer-driven green strategy as an 'outside-in' approach that guides, facilitates, and supports the efficacy of green value co-creation in helping firms manage and exploit green process innovation for competitive advantage (Slack & Lewis, 2020). With a strong customer-driven green strategy, firms can better understand how to engage customers in green value co-creation activities and fully capitalize on such processes to benefit green process innovation. Without a customer-driven green strategy, firms engaging in green value co-creation may miss opportunities to develop a robust understanding of the dynamics of market requirements to enable them to configure green process innovation to generate superior value for customers.

In contrast, while customer-driven green strategy can help firms align their competencies and product offerings with market requirements, firms may also struggle to successfully implement this strategy without emphasizing green value co-creation. As argued in Hypothesis 1, green value co-creation provides a crucial platform for tapping into and incorporating market intelligence to enable firms to properly manage and exploit green process innovation. Therefore, by extension, low levels of both green value co-creation and customer-driven green strategy may result in limited financial benefits of green process innovation. Specifically, under such conditions, the drawbacks of green process innovation may outweigh its benefits to the extent that firms would lack appropriate market strategy and knowledge resources to guide investment decisions in green process innovation. In such

situations, emphasis on green process innovation can be counterproductive, limiting financial performance. These arguments lead to the study's second hypothesis:

Hypothesis 2. *The interaction between green value co-creation and customer-driven green strategy moderates the relationship between green process innovation and financial performance. Specifically, conditions of high levels of both contingencies amplify the contribution of green process innovation to financial performance. In contrast, the contribution of green process innovation to financial performance is weaker in conditions defined by low levels of both contingencies.*

3. Methodology

3.1. Empirical setting

The proposed hypotheses of the study are tested on a sample of manufacturing SMEs in Ghana. Ghana is considered a model country and an attractive investment destination in Sub-Saharan Africa because of its open economy policies and stable political climate (Danso et al., 2019). The successive governments of Ghana have promoted industrialization policy interventions that have created an improved business environment for industrial activities. However, the growing industrial activities have triggered concerns about the environmental impacts of some industrial activities and the tendency of firms to rely on outdated and environmentally unfriendly industrial technologies (Appiah & Essuman, 2024). For example, the Yale Center for Environmental Law & Policy's environmental performance ranking shows that Ghana underperforms on the environmental management matrix, ranking 170 out of 180 countries (Wolf et al., 2022).

Several other reasons make the manufacturing sector in Ghana a suitable empirical setting for studying financial performance outcomes of green process innovation. Firstly, global greenhouse emission trends have shifted towards developing economies in the last three decades (Mishra & Yadav, 2021). Growing industrialization of the Ghanaian economy suggests that this Sub-Saharan African country could encounter severe environmental challenges soon due to increasing manufacturing activities (Kraus et al., 2020). Secondly, like other Sub-Saharan African countries, Ghana lags behind other countries in terms of ecological health and ecosystem vitality (Wolf et al., 2022). Thirdly, green innovations are expensive, risky, and far more complicated in a low-resource environment such as Ghana (Yao et al., 2019), where regulatory institutions and governance mechanisms are weak, consumer attention toward environmentalism is low, and firms are resource-constrained (Boso et al., 2017). Thus, relying on data from SME manufacturers in Ghana helps broaden scholarly understanding of the relationship between green process innovation and financial performance in developing economies (Achi et al., 2022; Khan et al., 2021).

3.2. Research design and data collection

Obtaining secondary and archival data on firm-level constructs in developing economies is a major hurdle for researchers as reliable databases are difficult to access (Essuman et al., 2023). Consequently, this study used a survey research design in the form of a structured questionnaire to obtain primary data from senior managers (e.g., CEOs, General Managers, and Marketing Managers) with extensive industry and managerial experience (i.e., an average of 9.91 and 7.54 years, respectively). Given the relatively small size of the firms studied, it can be argued that the senior executives contacted are likely to have substantial knowledge about their firms' resources, operations, and performance indicators. This research design follows that of previous research on green process innovation and financial performance (e.g., Xie et al., 2022; Achi et al., 2022; Wang et al., 2021) and other management research involving SMEs in Ghana (e.g., Essuman et al., 2023; Fianko et al., 2023).

The study relies on the Ghana Yello database (<https://www.ghana.yello.com>) to generate a sample of 672 autonomous manufacturing firms that have operated in the country for at least three years and employ between five and 400 full-time staff (Fianko et al., 2023). The fieldworkers, working under the close supervision of the researchers, delivered the questionnaires in person to 576 accessible firms. Following several follow-ups, 224 valid questionnaires were retrieved (i.e., 38.89 % effective response rate). The sample comprises multi-sector manufacturing firms, with a typical firm employing about 22 full-time staff and having been in operation for 15.17 years. Table 2 presents details of the sample and key informants.

Because the executives contacted occupy different positions and may interpret organizational issues differently, the study examined the extent to which the respondents' managerial position affected the data (Essuman et al., 2021). An analysis of variance indicates that the informant's position does not account for variations in the data: financial performance ($F = 0.749, p = 0.559$), green process innovation ($F = 1.906, p = 0.111$), green value co-creation ($F = 1.561, p = 0.186$), and customer-driven green strategy ($F = 1.173, p = 0.324$).

3.3. Measurement of constructs

While some past studies have utilized secondary and objective data (where available) to measure green process innovation and financial performance (e.g., Xie et al., 2019; Yao et al., 2019), others have opted for survey and perceptual data (e.g., Opazo-Basáez et al., 2024; Achi et al., 2022). This study followed the latter approach due to challenges in obtaining secondary and objective data from SMEs in Ghana (Essuman et al., 2023). Consistent with related past studies, the study employed multi-item scales to measure all substantive variables, providing an avenue to assess the reliability and validity of data before testing the research hypotheses (Bhatia, 2021; Achi et al., 2022). The indicators, derived from past studies, are presented in Table 3 along with information on their psychometric properties. The study used different scale formats to measure the constructs to mitigate common method bias (Podsakoff et al., 2012).

3.3.1. Substantive variables

Green process innovation: The study adapted five items from Chen et al. (2006) and Wong (2013) to measure green process innovation. Sample items are 1) the manufacturing process of our company recycles waste and emission in a way that allows them to be treated and re-used, and 2) the manufacturing process of our company redesigns production and operation processes to improve environmental efficiency. The informants used a seven-point scale ranging from "strongly disagree (=1)" to "strongly agree (=7)" to evaluate the items ($\alpha = 0.864$).

Green value co-creation: The study adapted five items from Chang (2019) to measure green value co-creation. Two of the items are 1) when developing new products/processes, our company shares ideas with partners (suppliers and customers) during the green product development process; and 2) when developing new products/processes, our company spares time and effort to share its suggestions with its partners to improve its products and/or processes further. The informants used a seven-point scale ranging from "strongly disagree (=1)" to "strongly agree (=7)" to evaluate the items ($\alpha = 0.892$).

Customer-driven green strategy: The study measured this construct with four items, adapted from Hofman et al. (2020). Sample items are our company develops innovative processes that preserve the natural environment in response to 1) current market demand from our customers for products with lower environmental impacts; 2) increased awareness of environmental issues among our customers. The informants used a seven-point scale ranging from "strongly disagree (=1)" to "strongly agree (=7)" to evaluate the items ($\alpha = 0.908$).

Financial performance: The study adapted six items from Danso et al. (2019) to measure financial performance. Using a seven-point scale ranging from "far below industry average (=1)" to "far above industry

Table 2
Sample and key informant characteristics.

Variable	Category	Count	Percentage	
Firm industry	Industrial machinery, machine, tools	8	3.6	
	Chemicals	2	0.9	
	Plastics & rubber	12	5.4	
	Food, beverages, and drinks	59	26.3	
	Metals, metalworking	39	17.4	
	Pharmaceutical, healthcare	8	3.6	
	Paper and packaging	14	6.3	
	Engineering, construction	20	8.9	
	Textiles and clothing	12	5.4	
	Electronics	5	2.2	
	Others (Woodworks, paint, etc.)	45	20.1	
	Informant's position	CEO	54	24.1
General manager		33	14.7	
Marketing/sales manager		64	28.6	
Operations/production manager		55	24.6	
Others (e.g., supply chain manager)		18	8.0	
<i>Variable</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>SD</i>
Firm size (number of full-time employees)	6	384	21.56	34.61
Firm age (number of years in operation)	3	45	15.17	7.47
Key informant's industry experience (years)	2.00	40.00	9.9107	6.57
Key informant's positional experience (years)	2.00	40.00	7.5446	5.41

average (=7)", the informants indicated their firms' financial performance for the most recent past year: profitability, net profit margin, return on investment, return on asset, return on equity, and overall financial performance ($\alpha = 0.946$).

3.3.2. Control variables

To address omitted variable bias and endogeneity concerns, several internal and external environmental factors that may affect the variables and relationships in the study's conceptual model were included in the study (Lu et al., 2018). Specifically, the study controlled for firm size, firm age, environmental orientation, proactive behavior, risk-taking behavior, customer dynamism, stakeholder pressure, and technological turbulence.

Though SMEs were studied, they differ in size. Compared to small firms, medium-sized firms are more likely to accumulate critical resources (e.g., financial resources) for supporting green process innovation and implementing strategies that enhance financial performance (Rahman, 2023). Older firms may have more industry experience that can help them better understand and respond to organizational issues with implications for financial performance (Essuman et al., 2023). The study operationalized firm size and firm age as the natural logarithm transformations of the number of full-time employees and the number of years the firms have been in operation, respectively (Achi et al., 2022).

Table 3
Measurement items and validity assessment.

Construct/Measures (Composite reliability; Average variance extracted)	Factor loading	T-value	VIF
Green process innovation ^a (CR = 0.866, AVE = 0.564)			
<i>The manufacturing process of our company... effectively reduces the emission of hazardous substances or waste</i>	0.768	12.945	–
<i>recycles waste and emission in a way that allows them to be treated and re-used</i>	0.782	13.272	–
<i>reduces the consumption of resources (e.g., water, electricity)</i>	0.727	11.947	–
<i>reduces the use of raw materials</i>	0.696	11.296	–
<i>redesigns production and operation processes to improve environmental efficiency</i>	0.779	13.186	–
Customer driven green strategy ^a (CR = 0.909, AVE = 0.714)			
<i>Our company develops innovative processes that preserve the natural environment in response to ...</i>			
<i>current market demand from our customers for products with lower environmental impacts</i>	0.802	14.057	–
<i>increased awareness of environmental issues among our customers</i>	0.878	16.161	–
<i>customers demonstrated preferences for green products</i>	0.852	15.430	–
<i>customers continuous attention to our company's environmental behavior</i>	0.845	15.213	–
Green value co-creation ^a (CR = 0.894, AVE = 0.627)			
<i>When developing new products/processes, our company...</i>			
<i>shares ideas with partners (suppliers and customers) during the green product development process</i>	0.747	12.689	–
<i>saves time and effort to share its suggestions with its partners to improve its products and/or processes further</i>	0.744	12.566	–
<i>has easy access to information about partners' environmental preferences</i>	0.833	14.906	–
<i>aligns with its partners' environmental requirements</i>	0.850	15.390	–
<i>ensures its partners have a crucial role to play in green product/process development</i>	0.780	13.470	–
Financial performance ^a (CR = 0.946, AVE = 0.746)			
<i>Relative to industry average, how well did your company perform in each of the following areas in the past financial year?</i>			
<i>Profitability</i>	0.828	14.962	–
<i>Net profit margin</i>	0.865	16.073	–
<i>Return on investment (ROI)</i>	0.851	15.653	–
<i>Return on assets (ROA)</i>	0.871	16.248	–
<i>Return on equity (ROE)</i>	0.863	15.989	–
<i>Overall financial Performance</i>	0.902	17.208	–
Customer dynamism ^a (CR = 0.901, AVE = 0.752)			
<i>Our customers' product preferences change quite a bit over time</i>	0.880	15.989	–
<i>Our customers tend to look for new products all the time</i>	0.824	14.546	–
<i>We are witnessing changes in the type of products demanded by our customers</i>	0.896	16.460	–
Environmental orientation ^a (CR = 0.857, AVE = 0.602)			
<i>In this company...</i>			
<i>there is a concerted effort to let all employees understand the importance of environmental preservation</i>	0.845	14.715	–
<i>there is a clear policy statement urging environmental awareness in every area of operations</i>	0.835	14.428	–
<i>environmental preservation is highly valued by organization members</i>	0.708	11.539	–
<i>environmental preservation is a central corporate value of our organization</i>	0.704	11.445	–
Proactive behavior ^a (CR = 0.896, AVE = 0.744)			

Table 3 (continued)

Construct/Measures (Composite reliability; Average variance extracted)	Factor loading	T-value	VIF
<i>We seek to exploit anticipated changes in our target market ahead of rivals</i>	0.768	13.193	–
<i>We seize initiatives whenever possible in our target market operations</i>	0.912	16.990	–
<i>We act opportunistically to shape the environment in which we operate</i>	0.900	16.610	–
Risk taking behavior ^a (CR = 0.932, AVE = 0.821)			
<i>We take above-average risks in our business</i>	0.858	15.747	–
<i>Taking chances is an element of our business strategy</i>	0.916	17.597	–
<i>Our strategy can be characterized by a strong tendency to take risks</i>	0.943	18.470	–
Technological turbulence ^a (CR = 0.896, AVE = 0.767)			
<i>Digital technologies used in our industry change rapidly</i>	0.832	14.846	–
<i>Existing digital technologies in our industry are quickly replaced by new ones</i>	0.906	16.854	–
<i>Major digital technological developments are occurring in our industry</i>	0.888	16.311	–
Stakeholder pressures ^b			
<i>To what extent does each of the following stakeholders expressly demand that your company show greater commitment to environmental preservation?</i>			
<i>Regulators (e.g., Environmental Protection Agency)</i>	–	–	1.572
<i>Major customers</i>	–	–	2.044
<i>Major suppliers</i>	–	–	2.847
<i>The media</i>	–	–	2.192
<i>Company employees</i>	–	–	2.182
<i>The community in which your company operates/ community leaders</i>	–	–	1.698
<i>Financial institutions</i>	–	–	2.484
<i>Investors</i>	–	–	2.479
<i>Company senior executives</i>	–	–	1.799

Notes:

^a = Measured with reflective indicators; ^b = Measured with formative indicators.

Scales: Indicators for financial performance were rated on a seven-point scale ranging from “far below industry average” (=1) to “far above industry average” (=7); Indicators for stakeholder pressures were rated on a seven-point scale ranging from “not at all” (=1) to “the largest extent (=7)”; Indicators for all other constructs were rated on a seven-point scale ranging from “strongly disagree (=1)” to “strongly agree (=7)”.

Environmental orientation is an important organizational culture that can support green process innovation, green value co-creation, and customer-driven green strategy (Chan et al., 2012). Moreover, extant literature suggests that proactive and risk-taking behaviors can drive green process innovation (Boso et al., 2013; Jambulingam et al., 2005). Similarly, green process innovation tends to increase when the following external environment factors take on high values: technological turbulence (Cadogan et al., 2003), customer dynamism (Cadogan et al., 2003), and stakeholder pressure (Ahinful et al., 2019).

The study used four items from Chan et al. (2012) to measure environmental orientation (sample item: in this company, there is a clear policy statement urging environmental awareness in every area of operations [$\alpha = 0.854$]). Three items from Boso et al. (2013) were used to measure proactive behavior (sample item: we seek to exploit anticipated changes in our target market ahead of rivals [$\alpha = 0.894$]). Additionally, three items from Jambulingam et al. (2005) were used to capture risk-taking behavior (sample item: We take above-average risks in our business [$\alpha = 0.931$]). The study adapted three items each from Cadogan et al. (2003) to measure technological turbulence (sample item: existing digital technologies in our industry are quickly replaced by new ones [$\alpha = 0.908$]) and customer dynamism (sample item: our customers' product preferences change quite a bit over time [$\alpha = 0.900$]). Finally, nine

items were adapted from Ahinful et al. (2019) to measure stakeholder pressure as a formative construct. The items measured the extent to which key stakeholders including major customers, suppliers, the media, company employees and regulators required the firms to demonstrate commitment to environmental preservation (largest variance inflation factor = 2.847). The informants used a seven-point scale ranging from “strongly disagree (=1)” to “strongly agree (=7)” to evaluate the items tapping into these control variables.

3.4. Measure validation and common method variance assessment

The study used covariance-based confirmatory factor analysis in Mplus 7.4 to validate the reflective indicators (Bagozzi & Yi, 2012). To concurrently assess the psychometric properties of the data, the analysis was performed on all the indicators. The multi-factor CFA model fits the data: $\chi^2 = 875.337$, $df = 558$, $\chi^2/df = 1.569$, RMSEA = 0.051, SRMR = 0.048, NNFI = 0.940, CFI = 0.947 (Bagozzi & Yi, 2012). Cronbach’s alpha and composite reliability are both greater than 0.70. All the items load significantly on their respective constructs, and the average variance extracted (AVE) is above 0.50, which provides evidence of convergent validity. Fornell and Larcker’s (1981) inter-construct correlations-AVE technique was used to assess discriminant validity. As shown in Table 4, the square roots of the AVEs are larger than the inter-construct correlations, indicating discriminant validity. Accordingly, each set of reflective indicators was averaged to represent their theoretical construct to test the structural model (Bode et al., 2011).

A formative index was created for the stakeholder pressure construct as an unweighted linear sum of its indicators (Bode et al., 2011) as the indicators are assumed to cause the existence of the construct. The possibility for multicollinearity was checked by examining the variance inflation factors (VIFs) of the indicators used to create the formative index. As shown in Table 3, all the VIF values are below 3.00, indicating that multicollinearity is not a concern (Bode et al., 2011).

Several procedural measures were implemented at the survey instrument development and administration stages to minimize common method bias (Hulland et al., 2018; Podsakoff et al., 2012). For example, the study followed a rigorous measurement and questionnaire development procedure to improve clarity and minimize social desirability. Also, informants were granted anonymity of their responses and assured that no answers were right or wrong. Again, the study ensured that the survey instrument did not include information about the labels of the constructs included in the study, and the hypotheses tested were not made explicit in the survey instruments. Further, the study ensured a proximal separation of the items for the substantive constructs in the study by placing other items, such as those for control variables, between them (Podsakoff et al., 2012).

In addition, CFA procedures were followed to examine the extent to

which common method bias described the data. Specifically, chi-square test of difference was used to compare a trait-only model (Model 1) with a trait and method model (Model 2) (Hulland et al., 2018). Model 1, representing the study’s theoretically specified measurement model, links each reflective item to its intended construct. As reported above, Model 1 fits the data well. Model 2 includes the relationships in Model 1 and an unmeasured latent factor. The study set this factor to load equally on all items and specified it to be uncorrelated with the theoretical constructs in Model 1 (Bode et al., 2011). Model 2 equally fits the data: $\chi^2 = 874.403$, $df = 557$, $\chi^2/df = 1.479$, RMSEA = 0.051, SRMR = 0.048, NNFI = 0.940, CFI = 0.947. However, the two models are not statistically different: $\Delta\chi^2 = 0.934$, $\Delta df = 1$, $p > 0.05$. Furthermore, Model 1 and Model 2’ factor loadings are highly correlated ($r = 0.99$, $p < 0.001$) (Bode et al., 2011). These results suggest that common method bias is unlikely to confound the study’s conclusion, especially given that the study’s theoretical model incorporates a complex set of interaction terms (Podsakoff et al., 2012).

3.5. Endogeneity control and test

The study recognizes that the relationship between green process innovation and financial performance may suffer from simultaneity and reverse causality problems. For example, while green process innovation may benefit financial performance, financially successful firms may build more financial slack to engage in greater green process innovation activities (Rahman, 2023). The study addresses this concern by measuring financial performance in the most recent period. Because omitted variables may contribute to endogeneity bias, the study employed a control variable approach to alleviate this concern (Lu et al., 2018; Ketokivi & McIntosh, 2017). As discussed in Section 3.3.2, the study included several internal and external environmental control variables that may not only influence strategic decisions regarding green process innovation but also levels of financial performance. Table 4 shows most of the controls have significant associations with the substantive variables in the study, indicating their relevance. Furthermore, the survey instrument was carefully designed and implemented to minimize measurement error (Ketokivi & McIntosh, 2017).

Notwithstanding, the study statistically investigated potential endogeneity concerns by implementing a two-stage least squares (2SLS) regression with instrumental variables (Ketokivi & McIntosh, 2017). One external environment factor (i.e., customer dynamism) and one firm-specific factor (i.e., firm age) were used as instrumental variables. Customer dynamism may affect firms’ propensity to innovate processes in response to changing customer demands; however, dealing with changing customer needs and wants does not guarantee financial performance. Older firms may have more experience executing process changes and environmental strategies, but firm age does not necessarily

Table 4
Descriptive statistics, correlations, and square root of AVEs.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Green process innovation	0.751											
2. Financial performance	0.306**	0.864										
3. Green value co-creation	0.638**	0.436**	0.792									
4. Customer-driven green strategy	0.461**	0.238**	0.591**	0.845								
5. Environmental orientation	0.387**	0.289**	0.593**	0.476**	0.776							
6. Stakeholder pressure	0.402**	0.353**	0.503**	0.547**	0.443**	n/a						
7. Proactive behavior	0.287**	0.471**	0.416**	0.226**	0.317**	0.333**	0.863					
8. Risk-taking behavior	0.394**	0.275**	0.359**	0.232**	0.187**	0.337**	0.418**	0.906				
9. Technological turbulence	0.303**	0.315**	0.251**	0.297**	0.184**	0.476**	0.284**	0.482**	0.876			
10. Customer dynamism	0.354**	0.054	0.254**	0.157*	0.207**	0.262**	0.233**	0.382**	0.154*	0.867		
11. Firm size	-0.040	0.296**	0.100	-0.032	0.175**	0.229**	0.147*	-0.067	0.142*	-0.019	n/a	
12. Firm age	0.056	0.057	0.130	-0.056	0.013	-0.056	0.077	0.034	-0.111	0.125	0.407**	n/a
Mean	4.680	4.319	4.135	4.416	4.483	31.290	5.015	3.635	3.402	3.842	21.558	15.169
SD	1.015	1.289	1.287	1.184	1.194	10.871	1.183	1.654	1.615	1.510	34.605	7.470

Notes: Value on the principal diagonal are the square roots of the average variance extracted (AVE); n/a = not applicable; * $p < 0.05$ (2-tailed); ** $p < 0.01$ (2-tailed).

affect financial performance. Sargan overidentification test (Hansen J-test) confirms the validity of these instruments ($\chi^2 = 0.57, p = 0.45$). The outcome of the Durbin-Wu-Hausman test indicates that the study's predictor variable (i.e., green process innovation) is less likely to be endogenous (Durbin $\chi^2 = 0.777, p = 0.38$, Wu-Hausman $F = 0.77, p = 0.38$), as there is no systematic difference between the OLS and the 2SLS approaches to estimating the relationships. Therefore, endogeneity concerns may not threaten the study's results.

4. Hypothesis testing and Evaluation

Table 4 presents descriptive statistics and correlations for the variables included in the study. Moderated regression analysis, together with Hayes' PROCESS macro, is used to test and visualize the moderating effect hypotheses. In addition, simple slope tests were conducted to determine the levels of the moderators in which changes in the relationship between green process innovation and financial performance are (in)significant (Hayes, 2018). Because there are several product terms (i.e., three two-way interactions and one three-way interaction), and to effectively visualize the moderating effect relationships, all variables involved in creating product terms were mean-centered (Hayes, 2018). As detailed in Table 5, moderated hierarchical regression models are estimated to test Hypothesis 1 and Hypothesis 2.

The results (see Model 1) show that the interaction between green process innovation and green value co-creation is positively related to financial performance: $\beta = 0.199, t = 3.536, p < 0.01$. A slope analysis reveals that at one standard deviation below the mean value of green value co-creation, green process innovation has a negative, albeit insignificant, relationship with financial performance ($\beta = -0.061, t = -0.587, p > 0.05$). In contrast, the relationship is positive and significant at one standard deviation above the mean value of green value co-creation ($\beta = 0.451, t = 3.317, p < 0.01$). These results, as displayed in Fig. 2, indicate that green process innovation has a stronger positive association with financial performance under high conditions of green value co-creation, supporting Hypothesis 1.

Additional results (see Model 2) show the three-way negative interaction among green process innovation, green value co-creation, and customer-driven green strategy has a significant negative effect on financial performance ($\beta = -0.095, t = -2.590, p < 0.001$). To interpret this three-way interaction finding, a slope analysis was conducted to show how green process innovation is associated with financial performance at specific levels (± 1 standard deviation) of green value co-creation and customer-driven green strategy (Hayes, 2018). The results, as presented in Fig. 3, indicate that green process innovation has a stronger positive association with financial performance when both green value co-creation and customer-driven green strategy take on high values ($\beta = 0.463, t = 3.252, p < 0.01$), compared to when both moderators take on low values ($\beta = -0.270, t = -1.400, p > 0.05$). While these results support Hypothesis 2, they also reveal that green process innovation has the strongest positive relationship with financial performance when green value co-creation is high while customer-driven green strategy is low ($\beta = 0.774, t = 3.159, p < 0.001$).

5. Discussion

This study sought to advance scholarly work on when green process innovation pays (Opazo-Basáez et al., 2024; Tariq et al., 2023). Accordingly, the study used resource orchestration theory (Schweiger et al., 2019; Sirmon et al., 2011) to offer a new theoretical explanation of the boundary conditions of the relationship between green process innovation and financial performance by answering the question: how does green value co-creation moderate the relationship between green process innovation and financial performance under varying conditions of customer-driven green strategy? Data from SMEs in a developing country reveals two key findings to corroborate the theorization of the study. Firstly, the results indicate that green value co-creation

Table 5
Regression results (dependent variable: financial performance).

	H1: Model 1	H2: Model 2
<i>Control path:</i>		
Customer dynamism	β (t-value) -0.087(-1.681)	β (t-value) -0.098(-1.918)
Environmental orientation	-0.029(-0.390)	-0.040(-0.544)
Stakeholder pressure	0.006(0.078)	0.040(0.510)
Technological turbulence	0.052(0.981)	0.059(1.089)
Proactive behavior	0.304(0.443)	0.322(4.721) **
Risk taking behavior	0.005(0.091)	-0.009(-0.157)
Firm size (log)	0.449 (4.003) **	0.488(4.379) **
Firm age (log)	-0.215 (-1.239)	-0.154(-0.894)
<i>Main effect path:</i>		
Green process innovation (GPI)	0.195 (2.011) *	0.322(3.100) **
Green value co-creation (GVC)	0.257 (2.931) **	0.250(2.883) **
Customer-driven green strategy (CDGS)	-0.058 (-0.727)	-0.002(-0.020)
<i>Two-way interaction path:</i>		
GPI \times GVC	0.199 (3.536) **	0.230(3.478) **
GPI \times CDGS		0.038(0.459)
GVC \times MIDS		-0.118 (-1.735)
<i>Three-way interaction path:</i>		
GPI \times GVC \times CDGS		-0.095 (-2.590) **
R ²	0.413	0.441
F of R ²	12.376 **	10.944 **
Highest VIF	2.764	2.786
Constant	2.5047	1.9617

Notes: * $p < 0.05$ (2-tailed); ** $p < 0.01$ (2-tailed).

moderates the relationship between green process innovation and financial performance. Specifically, increasing green process innovation enhances financial performance when firms emphasize green value co-creation activities with suppliers and customers. However, when green value co-creation initiatives are low, increasing green process innovation tends to lower financial performance (see Fig. 2). Secondly, the results show that the interaction between green value co-creation and a customer-driven green strategy negatively moderates the relationship between green process innovation and financial performance. Increasing green process innovation enhances financial performance when both green value co-creation and customer-driven green strategy are high but lowers financial performance when both are low. Notably, increases in

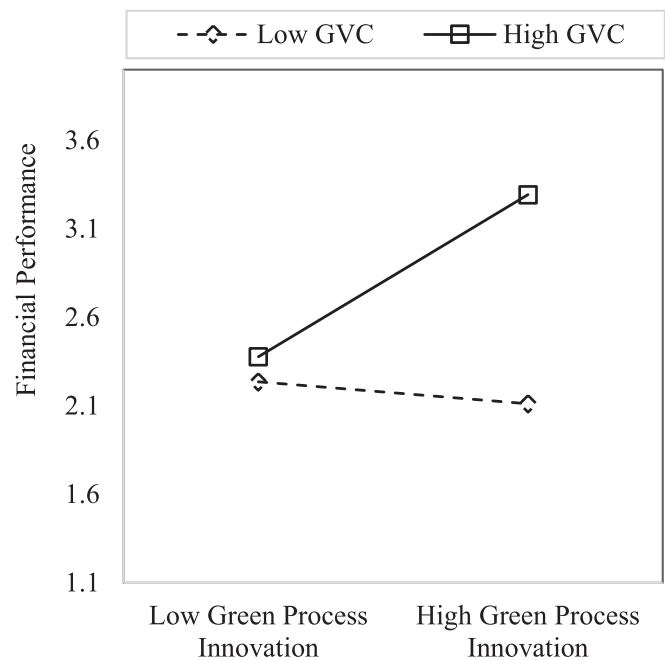


Fig. 2. Moderating effect of green value co-creation. Notes: GVC represents green value co-creation; low and high levels of the variables represent -1 and $+1$ standard deviation values of their mean values.

green process innovation benefit financial performance most when green value co-creation is high and customer-driven green strategy is low (see Fig. 3). These results broadly reinforce conclusions from past studies that the relationship between green process innovation and financial performance is context-dependent (e.g., Tariq et al., 2023; Achi et al., 2022; Xie et al., 2019).

5.1. Contributions and research implications

This study extends theoretical and empirical insights from past studies in several important ways. First, beyond shedding light on the unique moderating role of green value co-creation in the relationship between green process innovation and financial performance, the study reveals greater details about the relationship through a three-way interaction theorization and empirical analysis. The study unravels that the interaction between green value co-creation and customer-driven green strategy explains additional variability in financial performance. Compared to prior studies that offer two-way interaction insights (e.g., Tariq et al., 2023; Achi et al., 2022; Xie et al., 2022), this study’s results suggest that a three-way interaction model of green process innovation tends to have greater explanatory power and helps better understand the complexities that characterize the relationship between green process innovation and financial performance.

Second, findings from this study help to enrich prior studies that have largely focused on using a resource-based perspective to explain how green process innovation is associated with financial performance (e.g., Opazo-Basáez et al., 2024; Achi et al., 2022; Wang et al., 2021). Unlike prior studies, this study draws on the tenets of resource orchestration theory to explain how firms that engage more in green value co-creation generate greater financial benefits from investment in green process innovation (Sjödín, 2019; Menguc et al., 2014). This study’s theorization highlights the importance of recognizing heterogeneity in firms’ ability to structure, bundle, and leverage green process innovation (Schweiger et al., 2019). Firms with limited ability to orchestrate green resources are likely to adopt costly green process innovation with limited market value. To this end, the study builds on the strategy literature (e.g., Schweiger et al., 2019; Sirmon et al., 2011) to delineate how firms that engage in greater green value co-creation are more capable of orchestrating green process innovation for greater financial

benefits. Thus, the study enriches resource orchestration theory and its application (Schweiger et al., 2019; Sirmon et al., 2011) while reinforcing previous research on how supply chain partner involvement interacts with innovation factors to affect firm performance outcomes (Menguc et al., 2014).

Third, the study contributes to the literature on the interface between green value co-creation and innovation. Theoretical and empirical analyses in this literature treat green value co-creation as an antecedent of green innovation or firm performance outcomes (e.g., Liu et al., 2022; Yousaf, 2021; Chang, 2019). As discussed, the present study sheds theoretical insights on the resource orchestration roles of green value co-creation in converting green process innovation into enhanced financial performance. In extending existing theoretical perspectives of green value co-creation (e.g., service-dominant logic) (e.g., Tian et al., 2022), this study’s resource orchestration conceptualization of green value co-creation offers a compelling and alternative lens for researching the financial benefit outcomes of green value co-creation.

Fourth, the study develops and generates empirical insight to support a major tenet of resource orchestration theory that argues that appropriate market strategies are required to manage and leverage resources to create sustained competitive advantage (Sirmon et al., 2011; Teece, 2014). This study contends that customer-driven green strategy enriches the effectiveness of green value co-creation and its efficacy in enabling firms to manage and exploit green process innovation. The results broadly support this argument but also reveal that green value co-creation is most effective and beneficial for green process innovation when there is limited emphasis on a customer-driven green strategy. A plausible explanation is that pursuing a high customer-driven green strategy may stretch firm resources, at least in the short run. This can be particularly true for developing country SMEs, the empirical setting of this study, where acute resource constraints can limit the capacity of firms to leverage green process innovation resources for greater financial benefits (Kumar & Srivastava, 2020; Shankar & Narang, 2020).

Finally, in using a unique empirical setting, the study generates insights that help evaluate the generality of existing competing theoretical perspectives on the relationship between green process innovation and financial performance (e.g., Xu et al., 2023; Holzner & Wagner, 2022; Bhatia, 2021). Our multivariate empirical analysis incorporating main, two-way, and three-way interaction terms reveals that green process

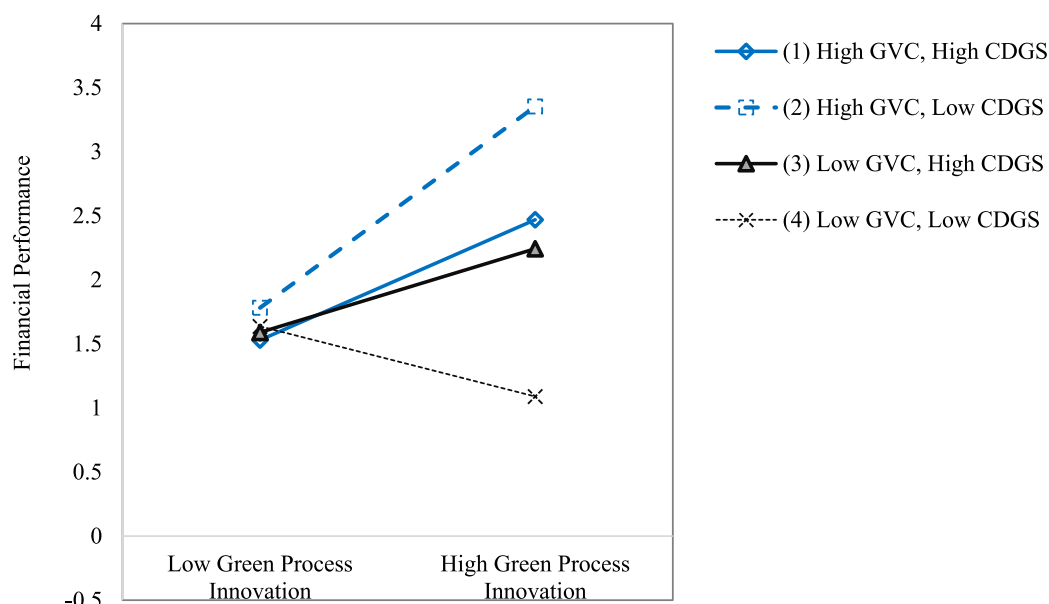


Fig. 3. Joint moderating effects of green value co-creation and customer-driven green strategy. Notes: GVC represents green value co-creation; CDGS represents customer-driven green strategy; low and high levels of the variables represent -1 and +1 standard deviation values of their mean values. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

innovation positively relates to financial performance in manufacturing SMEs in Ghana. This finding corroborates prior studies that argue and find that green process innovation benefits financial performance (Achi et al., 2022; Xie et al., 2019) but contradicts previous studies that suggest that it undermines financial performance (Holzner & Wagner, 2022; Yao et al., 2019). However, the study also reveals that the relationship between these variables is much more complex, determined by varying levels of the interaction between green value co-creation and customer-driven green strategy. These empirical insights address calls for more research on the relationship between green process innovation and financial performance in emerging and developing countries (Tariq et al., 2023; Xie et al., 2019), especially in Sub-Saharan Africa (Achi et al., 2022). Like many regions, Sub-Saharan Africa is characterized by unique market and non-market conditions that may have specific implications for the success of green innovations (Rahman, 2023; Achi et al., 2022). This study shows that manufacturing SMEs in Ghana that employ green value co-creation and with limited emphasis on customer-driven green strategy are likely to benefit more from green process innovation.

5.2. Managerial and policy implications

Beyond its normative value for environmental sustainability, green process innovation has the potential to enhance financial performance. However, implementing green process innovation may not only involve significant financial costs but also present considerable challenges, which could overwhelm SMEs. Notably, resource constraints and low green awareness in developing countries suggest that SMEs in these regions should go beyond merely adopting green process innovation. Instead, SMEs may find it useful to consider engaging in initiatives that enable them to build the necessary competences for effectively managing and translating such innovations into profitable outcomes.

Evidence from this study indicates that SMEs in developing countries can address this challenge by actively engaging with key suppliers and customers on green initiatives, such as the adoption of clean production technologies. For instance, SMEs can leverage these collaborations to acquire ideas, information, and support that will enable them to make more informed decisions regarding the appropriateness and cost-effectiveness of various green technologies and methods. It is important that SMEs develop a strategy that supports such collaborations, allowing them to effectively build information and knowledge resources for managing and deploying green process innovation. Specifically, SMEs in developing countries can adopt a green strategy that aligns their innovations with customer needs and expectations.

At the policy level, governments and interested stakeholders can assist SMEs by offering both financial support and competence-building programs that are essential for adopting and effectively managing green process innovations. The training programs designed to enhance the competencies of these firms should cover various topics and sessions, including fit-for-purpose and context-relevant green technologies and methods, collaborations with suppliers and customers in the design and implementation of green technologies, and the processes of strategy formulation, development, and implementation.

5.3. Limitations and future research

This study examines green process innovation and green value co-creation as unidimensional constructs. Extant literature, however, suggests that both concepts are multifaceted, raising concerns about the generality and robustness of the study's theorization and empirical results. It would, thus, be a fruitful endeavor for future studies to offer a more nuanced theorization and empirical assessment by employing multidimensional conceptualizations of green process innovation (e.g., clean technologies and end-of-pipe solutions [Khan et al., 2021]) and green value co-creation (e.g., co-creation comprising supply chain partners as information source, co-developers, and innovators [Cui, &

Wu, 2016]).

Theoretically, operations efficiency and green product innovation are two core mechanisms that link green process innovation to financial performance (Khan & Johl, 2019; Qiu & Wang, 2020). While the results about the direct relationship between green process innovation and financial performance support this assumption and are consistent with past studies (e.g., Achi et al., 2022; Xie et al., 2019), future studies can incorporate operations efficiency and green product innovation as intervening mechanisms to offer enhanced causal clarity on how green process innovation is related to financial performance. Furthermore, following insights from resource orchestration theory and manufacturing strategy literature, future studies can explore the boundary conditions roles of other strategies, such as business-level strategies (e.g., cost leadership and differentiation strategies) (Sirnon et al., 2011) and operations strategies (e.g., quality and flexibility strategies) (Alves Filho et al., 2015).

The study also has empirical and methodological limitations that should be addressed in future studies. The study's cross-sectional research design and data from SMEs in a single country limit causality claims and broader generalizations of the findings. While the focus of the study was to test a conceptual model rather than pursue an empirical generalization, the peculiarities of the sample (i.e., SMEs from a developing country) used to test the conceptual model raise questions about whether the results would apply in other settings, especially in SMEs or large firms in emerging and developed countries, where the business environment may be more benign and receptive to green initiatives (Kumar & Srivastava, 2020). Notably, locally-based and internationalized SMEs may differ in green process innovation and its associated benefits and costs, as the markets of the latter may demand greener production and products. Additionally, the study relied on single-source survey data, which is prone to common method bias. Although procedural and statistical remedies were utilized to address this concern, it cannot be completely ruled out of the study (Podsakoff et al., 2012). While re-testing the study's conceptual model in new settings is desirable, future research should explore alternative research designs (e.g., longitudinal) and data sources (e.g., archival and secondary sources) for operationalizing the study variables.

CRedit authorship contribution statement

Listowel Owusu Appiah: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Dominic Essuman:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Cassiel Ato Forson:** Writing – original draft, Validation, Resources, Conceptualization. **Nathaniel Boso:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis, Data curation, Conceptualization. **Jonathan Annan:** Writing – original draft, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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