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Co-innovation behavior and sustainable innovation in competitive environments

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Abstract

Despite substantial efforts in examining the drivers of sustainable innovation, we still do not know enough about the impact of co-innovation behavior. In this study, we investigated the effect of co-innovation behavior on sustainable innovation and the combinative effect of absorptive capacity and competitive intensity on this relationship. Data collected from 312 firms revealed that a firm's level of co-innovation behaviors is positively associated with sustainable innovation. Moreover, we find that the effect of co-innovation behaviors on sustainable innovation is amplified when absorptive capacity is high. Finally, the moderating effect of absorptive capacity is exacerbated by competitive intensity. These findings contribute to the co-innovation and sustainable innovation literature. The theoretical and practical implications are discussed.

KEYWORDS
absorptive capacity, co-innovation, competitive intensity, sustainable development, sustainable innovation

1 | INTRODUCTION

Global environmental challenges such as global warming, ozone depletion, water pollution, and deforestation are considered to be major obstacles to sustainable development. This development has prompted the United Nations (UN) to define Sustainable Development Goals (SDGs) as global priorities and as aspirations to eliminate extreme poverty and to put the world on a sustainable path. In addition, policymakers and international activist groups continue to put pressure on businesses to balance their economic performance with social and environmental practices (Varadarajan, 2014). More importantly, the demand for environmentally friendly products and services continues to grow globally (De Melo & Solleder, 2020; Strange & Bayley, 2014). For example, in developing countries, consumer concerns about sustainability are increasing (Lin et al., 2015) and the environmental priorities of multinational companies in global supply chains also present opportunities (Tong et al., 2018). This development has prompted business organizations to focus on sustainable innovations (Cheng & Shiu, 2012; Melnyk et al., 2003) to meet "the need of the future without compromising its ability to meet the needs of future stakeholders" (Brundtland, 1987, p. 12). Firms can develop sustainable innovations in the form of changes to an organization's products, and services to generate long-term social and environmental benefits while creating economic profits for the firm. For example, Bio-bean, a UK start-up developed an eco-friendly biofuel made from coffee waste to help power London's double-decker busses. Thus, through sustainable innovation, organizations can invent and offer novel products or services that directly contribute to achieving sustainable development.

To this end, organizations across the globe are trying to mitigate these challenges by adopting environmental duties and improving sustainable innovation activities (Cordano et al., 2010; Martinez et al., 2019; Nason et al., 2018). Given that future competitiveness is no longer defined as the struggle to remain competitive (Boons et al., 2013; OECD, 2011), firms have realized that it is important to put mechanisms in place to generate new knowledge that is underpinned by innovation. To address sustainability challenges, firms often

connect their business models to sustainable innovation by developing a balanced combination of economic, social, and environmental practices. However, the economic element is often paramount to firms, and the social and environmental aspects of sustainable innovation are frequently neglected (Nasiri et al., 2022; Ukko et al., 2021). For innovation to be considered sustainable, the social, environmental, and economic elements need to be integrated, and these elements of the innovation processes differentiate sustainable innovation from traditional innovation.

Although many firms spend a significant amount of financial capital on sustainable innovation activities (Boso et al., 2017; Hockerts & Wüstenhagen, 2010), a major issue is whether these firms pursue co-innovation activities to create value with sustainable innovation. Co-innovation that integrates external and internal resources is considered a new paradigm for value creation (Lee et al., 2012). Co-innovation behaviors reflect innovation practices relating to products and services through the exchange of knowledge between organizations (Chang et al., 2022; Lee et al., 2012). Provided that mutual learning enables firms to supplement their internal knowledge about how to develop new products (Lütjen et al., 2019; Markovic & Bagherzadeh, 2018), firms are able to acquire different values such as market share and decreasing time to market (van Blokland et al., 2008).

Though co-innovation is important for value creation, scholarly research has yet to investigate how and when co-creation behavior drives sustainable innovation. Within the realm of sustainable innovation literature, researchers have identified various factors that predict sustainable innovation (Adomako, 2020). However, our understanding of how and when co-innovation drives sustainable innovation is limited. Thus, in firms located in less developed markets, we still do not know the potential variations in sustainable innovation when co-innovation behaviors are used. Our study draws insights from the sustainable innovation literature (e.g., Adomako, 2020; Boons et al., 2013; Nill & Kemp, 2009) and the resource-based view (RBV) (Hart, 1995; Russo & Fouts, 1997) to argue that larger amounts of co-innovation activities improve sustainable innovation in developing countries due to the knowledge exchange between firms. Therefore, the main aims of this study were to examine the role of co-innovation behaviors in sustainable innovation and to highlight the conditions under which co-innovation influences sustainable innovation in developing economy firms.

Our study contributes to the literature in three specific aspects. First, we show that co-innovation behaviors improve sustainable innovation. This is important because our understanding of how co-innovation behaviors relate to sustainable innovation practices is limited. Second, we extend the research on how co-innovation behaviors interact with firm-level capabilities to increase sustainable innovation by arguing that absorptive capability plays a central role in converting co-innovation behaviors into greater sustainable innovation. Finally, we add to the literature by developing a nuanced understanding of how co-innovation and absorptive capability interact. Accordingly, we investigated how competitive intensity is related to the interaction of co-innovation and absorptive capability. Our contention is that absorptive capacity facilitates sustainable innovation, which is based on the notion that dynamic capabilities like absorptive capability are more pronounced in competitive environments (Zahra et al., 2006). In an environment characterized by competition, information exchange between organizations appears particularly important for firms.

The rest of the article is organized as follows. First, the theoretical background of the study is highlighted, and this is followed by the development of the hypotheses. Next, we present the sample and data collection procedures. The analysis of data and results are presented in the following section. Finally, the discussion of the results is presented, and future research directions are offered.

2 | THEORETICAL BACKGROUND AND HYPOTHESES

2.1 | The resource-based view and sustainable innovation

Extant research indicates that firms that pursue sustainable innovation activities tend to go beyond the regulatory requirements associated with sustainability (Adomako, 2020; Christmann, 2000), which allows them to outperform their counterparts that do not pursue any proactive environmental strategies (Hart, 1995; Russo & Fouts, 1997). RBV considers the rents generated from pursuing sustainability activities as an important competitive advantage (Peteraf, 1993; Russo & Fouts, 1997). Additionally, the sustainable innovation literature shows that firms who pursue sustainability have a superior competitive advantage (Adomako, 2020; Adomako & Nguyen, 2020; Oksanen & Hautamäki, 2015). Given that sustainability is a challenging pursuit, firms are likely to co-innovate with other firms to gain a superior competitive advantage.

Indeed, firms adopt the environmental, social, and economic paradigms of sustainable innovation because they understand that this helps them attain a competitive advantage (Boons et al., 2013; Cillo et al., 2019; Nasiri et al., 2022). A review of the literature shows that the term "sustainable innovation" has been widely used in the academic literature and the popular business press. However, the way it has been captured in the literature lacks consensus. For example, Carrillo-Hermosilla et al. (2010) defined sustainable innovation as "innovation that improves environmental performance" (p. 1075). Further, a technical paper by the European Commission (EC, 2008, p. 27) captured eco-innovation as "the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its life-cycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)". Additionally, the EC (2007) suggested an alternate definition of eco-innovation that could be linked to sustainable innovation: "Eco-innovation is any form of innovation aiming at significant and demonstrable progress toward the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy" (p. 205). Thus, sustainable innovation appears to have different meanings in different contexts due to spatial, temporal, and cultural embeddedness (Boons et al., 2013). Our current study defines sustainable

innovation as "the development of new products, processes, services and technologies that contribute to the development and well-being of human needs and institutions while respecting natural resources and regeneration capacities" (Tello & Yoon, 2008, p. 165). Further, previous research has argued that sustainable innovation is "innovation that improves sustainability performance" (Carrillo-Hermosilla et al., 2010, p. 1078).

The existing literature argues that sustainable innovation can be examined using the following three criteria: internal managerial, external relational, and performance evaluation. The managerial level considers the impact of innovation and sustainability. As for the external relational aspect, research has argued that a firm's ability to innovate is strongly influenced by its relational capital (Thomson & Heron, 2006). This perspective further argues that a firm's relational capital can significantly affect its environmental strategy (Sharma & Vredenburg, 1998; Zahoor & Gerged, 2021). A major argument related to this notion is that innovation is highly dependent on external and internal environments (Rauter et al., 2019). In terms of performance evaluation, researchers have argued that the main challenge for sustainable innovation lies in better understanding how innovation can improve firm performance and benefit society (Sun et al., 2020). Findings from the literature show that firms that undertake sustainable innovation tend to have a stronger long-term competitive advantage, which, in turn, increases the firm's value. For example, previous research has highlighted the role of sustainable innovation in a firm's long-term competitive advantage (Kahupi et al., 2021; Walsh & Dodds, 2017).

Relatedly, researchers have coined the terms "sustainability" and "innovation" to create the concept of sustainable innovation (Adomako, 2020; Saunila et al., 2018). Sustainable innovation follows the principles of sustainable development, which is defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN World Commission on Environment and Development, 1987, p. 54). Arguably, the integration of sustainable development principles (i.e., environmental, social, and economic) into business strategy is a requirement for corporate sustainability strategies (e.g., Edraki et al., 2014; Larson et al., 2011). With these principles, "innovation" is often considered to be an important way to add to the firm's sustainability strategies. Given that innovation involves products, services, processes, and organizational modes that reflect degree of novelty, the achievement of sustainable innovation requires innovations that could potentially disrupt the market for both manufacturers and customers (Schaltegger & Wagner, 2011). Therefore, the current study refers to "sustainable innovation" as an innovation that can improve sustainability performance which integrates environmental, economic, and social principles (Klewitz & Hansen, 2014).

2.2 | Co-innovation behavior and sustainable innovation

Co-innovation is considered a new paradigm in the value creation process. It has been suggested that sustainable innovation is driven by co-innovation through the integration of internal and external resources, which co-creates value (Bugshan, 2015; Lee et al., 2012). Co-innovation reflects the establishment of partnerships between organizations and their stakeholders that create and implement value (Chang et al., 2022). Thus, organizations' innovation efforts are completed by collaborating with external partners and stakeholders. This approach indicates that co-innovation results in diverse values for businesses. These include increased market share and improved time to market (van Blokland et al., 2008). In addition, firms' knowledge creation for innovation and its learning outcomes improve through co-innovation (Westerlund & Rajala, 2010). For example, organizations collectively seek intelligence and conduct crowdsourcing through formal channels or social networks. The main element of co-innovation that provides compelling experiences with stakeholders is value creation (Lee et al., 2012; Von Hippel et al., 2011).

Although previous research has highlighted the outcomes of co-innovation such as opportunity recognition (Chang et al., 2022), value creation (Barile et al., 2020; Lee et al., 2012), and inter-firm innovation (Bossink, 2002), the literature is still not clear about how co-innovation fosters sustainable innovation. However, we argue that co-innovation is valuable in contributing to sustainable innovation. First, by collaborating with their stakeholders to create and implement value (Chang et al., 2022), organizations are better positioned to satisfy the different stakeholders' needs and also to meet their objectives (Freeman, 1984; Laplume et al., 2008).

Second, the co-innovation literature indicates that organizations that seek to incorporate the input of external and internal resources for co-creation opens multiple channels of communication for new insights on sustainability (Danso et al., 2019; Salem et al., 2016). In addition, organizations tend to prioritize the integration of ideas from internal and external sources (Bugshan, 2015; Savage et al., 1991) and respond to sustainability issues because stakeholders have direct control of the necessary resources (e.g., labor, capital, institutional support). By failing to attend to their demands about environmental, social, and economic issues, organizations are likely to suffer severe consequences (Rueda-Manzanares et al., 2008). Thus, through co-innovation, organizations use new technologies to co-create value with external sources such as customers (Romero & Molina, 2011). By acknowledging and incorporating key stakeholders' interests, organizations are better able to convey the message that they are willing to embrace new ideas and practices (Gupta & Briscoe, 2020) related to sustainability activities. Therefore, we propose the following:

> **Hypothesis 1.** *Co-innovation behavior is positively associated with sustainable innovation.*

2.3 | The moderating role of absorptive capacity

A key tenet of the absorptive capacity construct is that it identifies and generates useful external information. It also has an outward-looking component that highlights how this knowledge is analyzed in combination with extant knowledge to best decide how to translate

this information into new products, technology applications, or firm capabilities (Engelen et al., 2014; Escribano et al., 2009). Deriving insights from the "strategic fit" paradigm, we link co-innovation behavior with sustainable innovation and integrate absorptive capacity into this relationship as a moderator. First, organizations with a high degree of co-innovation behavior are typically good at facilitating the co-creation of value with their external stakeholders (Ramaswamy, 2009). The ability to engage both internal and external constituents is likely to be a major condition for converting co-innovation behavior into sustainable innovation. A high degree of absorptive capacity makes innovative firms realize early on when an innovative product does not meet customer needs. Absorptive capacity ensures that co-innovation behavior is able to receive the information needed to proactively implement sustainable innovations required by both internal and external constituents of the organization (Liao et al., 2003). Second, absorptive capacity ensures that the firm is able to interpret and assimilate information that threatens product failure. This view is consistent with prior learning literature that argues that learning is more potent when prior knowledge and experience is extensive (Anderson et al., 1984). Moreover, absorptive capacity allows organizations to build new firm-level capabilities to respond to pressures from internal and external collaborators (Zahra & George, 2002). Finally, organizations with a strong degree of absorptive capacity tend to learn from failure. Therefore, for co-innovation behavior to yield substantial sustainable innovation practices, organizations must use their prior knowledge for new co-creation activities. Collectively, we suggest that the acquisition of new knowledge is likely to facilitate the successful conversion of co-innovation into sustainable innovation. Thus, we propose the following:

> **Hypothesis 2.** *The effect of co-innovation behavior on sustainable innovation is strengthened by absorptive capacity*.

2.4 | The moderating role of competitive intensity

In addition, we investigate a boundary condition of absorptive capacity's impact on the relationship between co-innovation behavior and sustainable innovation by examining how competitive intensity influences this linkage. Competitive intensity refers to a condition of rivalry among firms in the same industry in which firms' behavior largely reflects the action of industry players, ushering in conditions of uncertainty and unpredictability (Auh & Menguc, 2005; Jansen et al., 2006). The literature on dynamic capabilities suggests that intense competition is likely to make these capabilities more valuable (Engelen et al., 2014; Zahra et al., 2006). Accordingly, we contend that competitive intensity will moderate absorptive capacity's influence on the relationship between co-innovation behavior and sustainable innovation. In H2, we argued that absorptive capacity is crucial for co-innovation's full potential since absorptive capacity helps to identify knowledge-sharing opportunities. This capability is critical when competitive intensity is high. In competitive environments, the decision-making behavior of firms changes constantly, which signifies that opportunities for knowledge exchange for innovation emerge regularly. Thus, we argue that with a higher level of competitive intensity, absorptive capacity's influence on the link between co-innovation behavior and sustainable innovation grows for two reasons. First, at high levels of competitive intensity, firms that possess a higher number of co-innovation behaviors will increase their sustainable innovation activities so as to improve their sustainability footprint. Second, in competitive environments, a first-mover advantage can be endangered by competitors' actions such that firms may pursue sustainable innovation only when absorptive capacity enables these firms to produce commercially viable sustainable products earlier than anyone else. This is likely to help firms maximize time before a second entrant appears. Overall, we argue that the moderating influence that absorptive capacity has on the relationship between co-innovation behavior and sustainable innovation is in line with the nature of competitive environments, while non-competitive environments impose less challenging and complex conditions on firms' innovation activities. Therefore, we state the following:

> **Hypothesis 3.** *The moderating effect of absorptive capacity on the relationship between co-innovation behavior and sustainable innovation is stronger when competitive intensity is high*.

3 | METHOD

3.1 | Sample and data collection

To test our hypotheses, we collected data from the senior executives—chief executive officers (CEOs) and their deputies—of manufacturing firms operating in Ghana. The data were collected through two waves of questionnaire surveys conducted in January and July 2022. We randomly selected 850 medium-to-large firms from the database of the Ghana Business Directory. To gather information, we sent letters to the CEOs of each of the selected companies. The letter highlighted the purpose of the study and asked for their participation. To improve the response rate and the provision of reliable and accurate responses, we promised the respondents a summary of the results of the study if they included their company's address.

In wave 1 (i.e., 2 weeks after the letters were sent), we visited the selected companies and gave the questionnaires to the CEOs and agreed on a date to collect the completed questionnaires. This first wave sought to collect information on the independent variable (co-innovation behavior), the moderators (competitive intensity and absorptive capacity), and all control variables. After several visits to the head offices of the firms, we received 336 completed surveys. We discarded 11 questionnaires due to incomplete information, yielding 325 useable surveys.

The second wave was conducted 3 months after the first wave. The same CEOs and their deputies were asked to provide information

TABLE 1 Reliability and validity assessment

Description of the measurement items	Factor loadings
Co-innovation behavior: $\alpha = .86$; CR = 0.87; AVE = 0.64	
Our company has integrated the needs of partner organizations in developing new products or services.	0.80
We frequently apply the advice from partner organizations in co-creating new products or services.	0.81
We frequently integrate stakeholder needs in our innovation process.	0.82
We receive advice from external stakeholders in our R&D activities.	0.78
Acquisition: $\alpha = .89$; CR = 0.90; AVE = 0.64	
Our unit has frequent interactions with corporate headquarters to acquire new knowledge.	0.77
Employees of our unit regularly visit other branches.	0.79
We collect industry information through informal means (e.g., lunch with industry friends, talks with trade partners).	0.81
Other divisions of our company are hardly visited. (R)	0.82
Our unit periodically organizes special meetings with customers or third parties to acquire new knowledge.	0.85
Assimilation: $\alpha = .88$; CR = 0.90; AVE = 0.76	
We are slow to recognize shifts in our market (e.g., competition, regulation, demography). (R)	0.85
New opportunities to serve our clients are quickly understood.	0.87
We quickly analyze and interpret changing market demands.	0.90
Transformation: $\alpha = .92$; CR = 0.93; AVE = 0.69	
Our unit regularly considers the consequences of changing market demands in terms of new products and services.	0.76
Employees record and store newly acquired knowledge for future reference.	0.77
Our unit quickly recognizes the usefulness of new external knowledge compared to existing knowledge.	0.82
Employees hardly share practical experiences. (R)	0.83
We laboriously grasp the opportunities for our unit from new external knowledge. (R)	0.90
Our unit periodically meets to discuss consequences of market trends and new product development.	0.92
Exploitation: $\alpha = .91$; CR = 0.92; AVE = 0.79	
It is clearly known how activities within our unit should be performed.	0.89
Our unit has a clear division of roles and responsibilities.	0.90
We constantly consider how to better exploit knowledge.	0.93
Our unit has difficulty implementing new products and services. (R)	0.77
Employees have a common language regarding our products and services.	0.66
Competitive intensity: $\alpha = .90$; CR = 0.92; AVE = 0.69	
Competition in our local market is intense.	0.88
Our organizational unit has relatively strong competitors.	0.79
Competition in our local market is extremely high.	0.82
Price competition is a hallmark of our local market.	0.76
Sustainable innovation: $\alpha = .86$; CR = 0.87; AVE = 0.53	
We have introduced products, processes, organizational, or marketing innovations that reduce resources and materials per unit of production.	0.75
We have introduced products, processes, organizational, or marketing innovations that reduce energy use.	0.78
We have introduced products, processes, organizational, or marketing innovations that reduce carbon dioxide (CO_2) production.	0.85
We have introduced products, processes, organizational, or marketing innovations that replace materials with less polluting or hazardous substitutes.	0.80
We have introduced products, processes, organizational, or marketing innovations that reduce soil, water, noise, or air pollution.	0.70
We have introduced products, processes, organizational, or marketing innovations to recycle waste, water, or materials.	0.67
Financial performance: $\alpha = 84$; CR = 0.85; AVE = 0.74	
Return on assets	0.87
Return on investment	0.89
Profitability	0.82

on sustainable innovation and the control variables. Using a time-lag data collection approach allowed us to see causal relationships between variables. In addition, because the questionnaires were possibly completed by two different informants at different time periods, the potential common method bias problem resulting from using a single informant was controlled. The second wave yielded a total of 312 useable surveys. The 13 firms that were dropped from the sample could not be reached for the second survey or the information provided was incomplete. Thus, we used 312 responses for the analysis that were matched between wave 1 and wave 2, representing a 36.70% response rate.

The final sample contained firms with a mean age of 33.63 (SD = 22.68) years, and a mean size of 214 (SD = 63.36) full-time employees. To assess the non-response bias, early and late respondents were compared for the final sample. Results of t-tests showed that early respondents did not differ significantly ($p < 0.05$) from late-respondents in terms of firm age and size. Thus, nonresponse bias is not a major concern in our study.

3.2 | Measures

All the multi-item measures were captured on a seven-point Likert scale with anchors ranging from 1 = strongly disagree to 7 = strongly agree. Table 1 provides details of the measures, reliability and validity.

3.2.1 | Co-innovation behavior

Co-innovation behavior reflects the integration of new ideas from both internal (e.g., employees and shareholders) and external stakeholders (e.g., suppliers, partners, and customers) into the innovation strategy of firms. Accordingly, we adapted four items from Chang et al. (2022) to capture co-innovation behavior. A sample item is the following: "we frequently apply the advice from partner organizations in co-creating new products or services."

3.2.2 | Absorptive capacity

We captured absorptive capacity utilizing Jansen et al. (2005) scale. This scale has dimensions defined derived from Zahra and George (2002). The four dimensions entailing acquisition, assimilation, transformation, and exploitation were aggregated to arrive at a composite score for each firm. One composite score for the scale was estimated since the four dimensions showed high positive correlations, reflecting a one-factor structure.

3.2.3 | Competitive intensity

We used four items from Jansen et al. (2006) to measure competitive intensity. A sample item is "competition in our local market is intense."

3.2.4 | Sustainable innovation

The sustainable innovation scale was captured using six items from Delmas and Pekovic (2018). We asked respondents to evaluate their firms' sustainable practices between 2019 and 2021 concerning products, processes, and organizational and marketing practices that provide environmental benefits (Adomako, 2020).

3.2.5 | Control variables

Several variables were used because of their influence on our research model. Firm size was measured as the number of full-time employees, as larger firms tend to be more resourceful than smaller firms (Chen et al., 2015). Firm age was captured as the number of years the business has operated since its first sales. Firm age was entered as a control variable because older firms tend to possess an experience-based advantage that enables them to sustain growth better than younger firms (Autio et al., 2000). In addition, we controlled for financial performance since this variable allows firms to react to environmental performance (Chen et al., 2015). Three items from Judge and Douglas (1998) were used to capture financial performance. Finance managers were asked to report their firms' financial performances using the return on investment, return on assets, and profitability as key measures. These items were rated on a seven-point Likert scale ranging from 1 (far below the average) to 7 (far above the average). Finally, we controlled for founder/CEO age and education (1 = high school, 2 = higher national diploma, 3 = bachelor's degree, 4 = master's degree, and 5 = doctoral degree).

3.3 | Common method bias assessment

To control for common method bias (Podsakoff et al., 2012), we undertook procedural and statistical measures to attenuate common method bias concerns. Procedurally, we conducted a pilot test to check whether the items are subject to ambiguity. In addition, we promised to protect respondent anonymity during the data collection to reduce respondents' willingness to change their responses.

Statistically, we utilized the approach suggested by Carson (2007) and estimated a combined confirmatory factor analysis (CFA) model including all the multi-item scales and a common method factor was estimated to load on all items. It involves establishing two competing models: Model 1 (trait-only) allowed each indicator to load on its respective latent factor. The model fit was adequate ($\chi^2/df = 2.11$; RMSEA = 0.05; NNFI = 0.95; CFI = 0.96; SRMSR = 0.06). In Model 2, we estimated a trait-method model which linked a common factor to all the indicators. Results from Model 2 suggest acceptance ($\chi^2/df = 2.20$; RMSEA = 0.05; NNFI = 0.92; CFI = 0.95; SRMSR = 0.07). When Models 1 and 2 are compared, the results show that Model 2 is not materially better than Model 1. This suggests that the results of the study are not influenced by common method variance (Carson, 2007).

3.4 | Validity and reliability assessment

Prior to testing our hypotheses, we utilized the approach suggested by Anderson and Gerbing (1988) and refined all the multiple-item scales and assessed their reliability and validity. First, we performed an exploratory factor analysis (EFA) using principal component factors. The EFA resulted in factor solutions as theoretically postulated. Second, we conducted a CFA on all the multi-item constructs. The baseline model included eight factors (co-innovation behavior, acquisition, assimilation, exploitation, competitive intensity, sustainable innovation, and financial performance). The results demonstrated that this eight-factor model adequately fits the sample data (CFI = 0.95, IFI = 0.96, RMSEA = 0.06). Alternative models with fewer than eight factors indicated fit. The results of the CFA also showed that the standardized item loadings on the hypothesized factors are significant at the 0.01 level. This provides evidence of convergent validity. The composite reliability (CR) and average variance extracted (AVE) values exceeded the recommended thresholds of 0.70 and 0.50, respectively. This shows adequate convergent validity and reliability. The results also showed discriminant validity among all the constructs. Specifically, we found that the correlation between any pair of constructs in the model is less than the square root of the AVE of the two constructs. This suggests that each construct shares greater variance with its own indicators than with other constructs (Fornell & Larcker, 1981). In addition, none of the 99.9% confidence intervals of the inter-construct correlations were close to 1 ($p < .01$), indicating discriminant validity. Thus, our measures exhibit acceptable reliability and validity.

4 | ANALYTICAL PROCEDURE AND RESULTS

We utilized the stepwise regression technique to test our hypotheses. Prior to testing the hypotheses, we calculated the variance inflation factors (VIF) for all the regression models to test for multicollinearity. The results in Table 3 show that all VIF values were below 3.0, which is lower than the suggested cut-off value of 10 (Aiken & West, 1991). This suggests that no concerns regarding multicollinearity influence our findings. In addition, we used mean-centered variables for all controls and independent variables to attenuate potential multicollinearity concerns.

Table 2 presents the descriptive statistics and correlations of the variables. Table 3 depicts the regression models (Models 1–4). Model 1 contains only the control variables. Model 2 includes all the direct effect variables. The results in Model 2 demonstrate a significant and positive relationship between co-innovation behavior and sustainable innovation ($\beta = .23$, $p < .01$), which provides support for H1.

H2 proposed that absorptive capacity moderates the relationship between co-innovation behavior and sustainable innovation. Model 3 contains the results of H2, which adds the interaction between absorptive capacity and co-innovation behavior. The results indicate that absorptive capacity positively moderates the relationship between co-innovation behavior and sustainable innovation ($\beta = .39$, $p < .01$). This result provides support for H2. Figure 1 further provides support for H2. A simple slope test was conducted using the approach suggested by Aiken and West (1991). The results of the simple slope test show that the relationship between co-innovation behavior and sustainable innovation is positive when absorptive capacity is high ($b = 0.19$, $t = 2.62$, $p < .05$), whereas there is no significant effect of co-innovation behavior on sustainable innovation when absorptive capacity is low ($b = 0.04$, $t = 0.39$, $p > .10$). The findings further provide support for H2 in that co-innovation behavior is associated with sustainable innovation when absorptive capacity is high.

Model 4 tests H3, which stated that competitive intensity moderates the influence of absorptive capacity on the relationship between co-innovation behavior and sustainable innovation. The three-way interaction term was calculated by multiplying the mean-centered co-innovation behavior, absorptive capacity, and competitive intensity scores for each firm. The result of the three-way interaction is significant ($\beta = .46$, $p < .01$). This finding suggests that the moderation of absorptive capacity on the relationship between co-innovation behavior and sustainable innovation is generally influenced by competitive intensity (Aiken & West, 1991).

The direction of the moderation was established by plotting the slopes for the four relevant cases (combining high/low absorptive capacity and high/low competitive intensity) (Figure 2). We then investigated the resulting plots by conducting a slope difference test (Aiken & West, 1991). The results of the simple slope tests demonstrate significant differences between the slopes of "high absorptive capacity/high competitive intensity" and "low absorptive capacity/low competitive intensity" ($p < .05$). The results demonstrate no significant differences for non-competitive environments ($p > .10$). This supports the view that absorptive capacity is important to the relationship between co-innovation behavior and sustainable innovation in competitive environments but not in non-competitive environments.

Relating the direction of absorptive capacity's moderation of the relationship between co-innovation behavior and sustainable innovation in competitive environments, the simple slope test shows that, in competitive environments, the link between co-innovation behavior and sustainable innovation is significantly positive when absorptive capacity is high ($b = 0.36$, $t = 2.96$, $p < .01$). However, the results show no significant relationship between co-innovation behavior and sustainable innovation when absorptive capacity is low ($b = -0.10$, $t = -0.61$, $p > .10$). Collectively, these findings from the three-way interaction analysis provide support for H3.

4.1 | Robustness assessment

We ran several additional tests to substantiate the robustness of our findings. First, each model was estimated as independent of the control variables. The results show that the coefficients maintained their significance in terms of magnitude and hypothesized direction (Spector & Brannick, 2011). Second, to alleviate concerns of

TABLE 2 Descriptive statistics and correlations

Variables	Mean	*SD*	1	2	3	4	5	6	7	8
Firm age (log)	1.53	0.79								
Firm size (log)	2.31	0.98	0.05							
CEO age	48.11	8.41	0.07	−0.02						
Education	2.96	1.13	0.11	0.09	−0.11					
Financial performance	5.22	1.09	−0.05	−0.16*	−0.06	0.04				
Co-innovation behavior	5.14	1.11	−0.16	−0.16*	0.05	0.19**	0.26**			
Absorptive capacity	5.13	1.12	0.09	0.19**	−0.06	0.07	0.04	0.06		
Competitive intensity	4.68	1.04	0.13*	−0.04	−0.05	0.01	0.05	0.04	0.25**	
Sustainable innovation	4.80	1.20	−0.09	−0.13*	0.09	0.05	0.22	0.33**	0.10	0.11

Note: N = 312; *SD* = Standard Deviation.
*$p < .05$; **$p < .01$ (2-tailed test).

TABLE 3 Results of hierarchical regressions with sustainable innovation as dependent variable

Variables	Model 1	Model 2	Model 3	Model 4
Controls				
Firm size (log)	−0.06	−0.06	−0.06	−0.06
Firm age (log)	−0.11	−0.10	−0.09	−0.09
CEO age	0.06	0.05	0.05	0.05
Education	0.03	0.02	0.02	0.02
Financial performance	0.19**	0.17**	0.14*	0.13*
Main effects				
H1: Co-innovation behavior (CB)		0.23**	0.18**	0.14*
Absorptive capacity (AC)		0.05	0.03	0.03
Competitive intensity (CI)		0.05	0.04	0.04
Two-way interaction effects				
H2: CB × AC			0.39**	0.27**
CB × CI			0.11	0.09
AC × CI			0.06	0.04
Three-way interaction effect				
H3: CB × AC × CI				0.46**
Model fit statistics				
F-ratio	3.10	4.67	5.20	5.33
R-Square	0.25	0.28	0.34	0.37
Change in R-square		0.03	0.06	0.03
Adjusted R-square	0.19	0.24	0.32	0.34
Largest VIF	1.19	2.15	2.99	2.04

Note: N = 312; standardized coefficients are shown.
*$p < .05$; **$p < .01$.

multicollinearity, we went beyond the mean-centering approach and the inspection of interfactor correlations by following the recommendations of Echambadi and Hess (2007). Accordingly, we randomly drew 90% of the sample and reestimated the regression models. The rationale behind this approach is that multicollinearity is likely to result in unstable regression coefficients. We observed that the regression coefficients remain stable in terms of direction and magnitude, indicating that our moderation results are not influenced by multicollinearity. Third, we repeatedly ran the same moderated regression analysis models with randomly selected subsets of the sampled firms, from 90% of the sample down to 50% of the sample (see Boling et al., 2016). The results concerning all the hypotheses remained stable in terms of magnitude, direction, and significance. Finally, to assess the direction of the causality between co-innovation

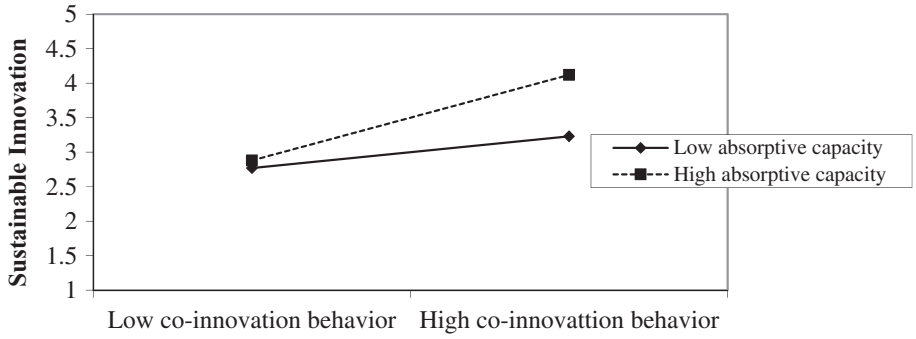

FIGURE 1 Interaction of co-innovation behavior and absorptive capacity on sustainable innovation

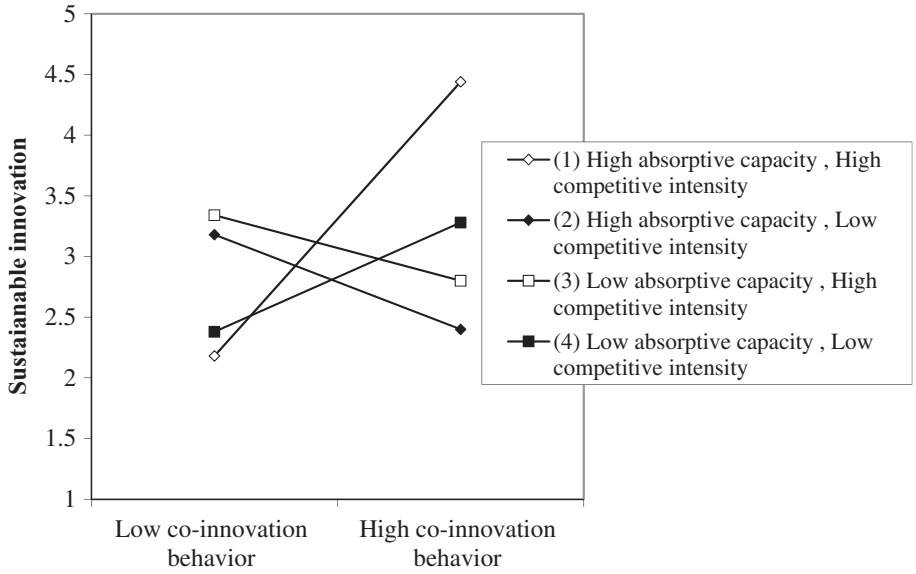

FIGURE 2 Interaction of co-innovation behavior, absorptive capacity, and competitive intensity on sustainable innovation

behavior and sustainable innovation, we used the approach suggested by Landis and Dunlap (2000). Accordingly, we set sustainable innovation as the independent variable and co-innovation behavior as the dependent variable and investigated the interactive effect of the new independent variable and the moderating variables (i.e., absorptive capacity and competitive intensity) on the new dependent variable. Given that none of the reverse integration terms are significant, we concluded that the reverse is not a major issue in our data. We also investigated the two moderators as antecedents of co-innovation behavior. A regression model with all the control variables yielded nonsignificant results.

5 | DISCUSSION AND IMPLICATIONS

Sustainable innovation requires organizations to actively incorporate issues such as those defined by the United Nations Sustainability Goals such as zero hunger, affordable, and clean energy, clean water, and so forth. Thus, sustainable innovation seeks to address those unintended social and environmental impacts. Despite the importance associated with sustainable innovation, little research has focused on how collaborative innovation such as co-innovation fosters sustainable innovation in organizations.

This study was motivated by the need to further understand the role a firm-level capability such as co-innovation behavior plays in driving sustainable innovation in emerging economies (Chang et al., 2022; Lee et al., 2012; Prashantham & Bhattacharyya, 2020) and was inspired by the impact that absorptive capacity has on this relationship in competitive environments. Furthermore, recent calls in co-innovation behavior literature highlight the need to understand how sustainable innovation is driven by such firm-level capabilities. Thus, the present study utilized insights from the sustainable innovation literature (e.g., Adomako, 2020; Boons et al., 2013; Nill & Kemp, 2009) and from the dynamic capabilities framework (Hart, 1995; Russo & Fouts, 1997) to develop theoretical arguments relating to how a firm's innovation behavior influences a firm's sustainable innovation strategy. It also examined how a dynamic capability like absorptive capacity facilitates the impact of co-innovation behavior and sustainable innovation. In addition, we introduce the degree of competitive intensity to highlight the boundary conditions of absorptive capacity's role in terms of the co-innovation behavior–sustainable innovation linkage. The empirical results from the analyses demonstrate that a firm's level of co-innovative behavior significantly predicts the level of sustainable innovation. Additionally, the findings indicate that absorptive capacity facilitates the relationship between co-innovation behavior and sustainable innovation, especially in

competitive environments. Overall, these findings offer several theoretical and practical contributions to the sustainable innovation literature.

5.1 | Theoretical implications

Our study offers theoretical evidence suggesting how co-innovation behavior influences sustainable innovation, particularly in the context of an emerging market such as Ghana. In addition, our findings enhance our understanding of the important boundary condition, highlighting when co-innovation behavior affects sustainable innovation, including absorptive capacity and competitive intensity. Thus, our findings contribute to several ongoing conversations in the sustainable innovation literature. First, our findings indicate a positive relationship between co-innovation and sustainable innovation, corroborating and strengthening existing sustainability literature (e.g., Adomako, 2020; Adomako & Tran, 2022; Khizar et al., 2022). This finding suggests that firms with stronger co-innovation behaviors have better chances of embarking on sustainable innovation activities (Barile et al., 2020; Dogliotti et al., 2014). Thus, we alleviate concerns relating to the functionality of the co-innovation construct and to the ambiguity concerning factors that could potentially affect the relationship between co-innovation and sustainable innovation (Adomako, 2020). This is crucial in the sustainability theory development because sustainable innovation requires co-innovations that can catalyze actions for the next generation of sustainable products and services. In particular, our understanding of the positive influence of co-innovation behavior on sustainable innovation, specifically in an emerging economy context, improves the generalizability of this theory, highlighting that innovation is directly tied to value creation and "shared value" (Lee et al., 2012).

In addition, although our findings indicate that co-innovation behavior directly predicts sustainable innovation, our examination of boundary conditions for this relationship offers a contribution in the form of nuance that can deepen the understanding of the corresponding nomological framework. Therefore, our second contribution demonstrates that the dynamic capability of absorptive capability facilitates the relationship between co-innovation behavior and sustainable innovation in competitive environments. This suggests that competitive intensity constitutes a boundary condition for absorptive capacity. This indicates that a specific degree of competitive intensity is required for absorptive capacity to have substantial value in the translation of co-innovation behaviors into sustainable innovation, especially in emerging economies. Investigating how absorptive capacity interacts with the task environment (Engelen et al., 2014) improves the understanding for how context can influence sustainability (Chan et al., 2016; Deslatte et al., 2017).

Finally, our findings theoretically contribute to the co-innovation literature (Lee et al., 2012) by highlighting that co-innovation behaviors foster sustainable innovation in a sub-Saharan African economy. Drivers of the co-innovation behavior of firms in emerging economies remain extremely underresearched, particularly in countries on the continent of Africa. The predominant focus of co-innovation in developed economies calls into question the generalizability of western theories and findings in developing and emerging economies. Thus, our study outlines new insights into how co-innovation activities help emerging market firms drive sustainable innovation. This is an important extension of the co-innovation literature because previous research has not explicitly investigated this issue in emerging and developing economies.

5.2 | Practical implications

Our findings have practical implications too. First, the findings show that co-innovation can potentially improve sustainable innovation activities in firms. This suggests that co-innovation is a precursor for sustainable innovation. The implication is that managers of emerging market firms should embark on collaborative efforts to improve sustainable innovation (Adomako, 2020). It is important to note that the field of innovation requires that firms leverage innovative ideas to introduce new products and services. Thus, the process of innovation requires collaborative efforts with internal and external stakeholders.

Second, the results of this study indicate that absorptive capability can help firms implement co-innovation to yield sustainability. Particularly, the dynamic capability that reflects the acquisition, assimilation, transferring and exploitation of new external knowledge helps firms to implement co-innovation more effectively and efficiently. This finding is particularly important for firms that operate in competitive environments, which are frequently characterized by intense competition, uncertainty, and changing customer needs. Sustainable innovation improves significantly when firms have the ability to generate, process, and utilize new external knowledge. Third, the finding that increases in co-innovation are related to improvement in sustainable innovation offers insights into the role of co-innovation in the sustainability activities of firms in emerging economies. This finding should be particularly relevant for firms operating in emerging economies, where the customer needs are characterized by greater uncertainty. Fourth, the finding that competitive intensity moderates the influence of absorptive capacity on the relationship between co-innovation and sustainable innovation is likely to help managers understand that co-innovation per se may not always influence sustainable innovation. Thus, it is important for managers to understand the crucial impact of the task environment in converting co-innovation into sustainable innovation. Given that sustainable innovation requires organizations to incorporate issues such as human rights, and climate change into their innovation processes, firms that engage in sustainable innovation create economic profits for the firm.

5.3 | Limitations and directions for future research

Our study has some limitations that open new avenues for future research. First, our study was conducted in Ghana, a sub-Saharan country, so the results of the study should be evaluated in the context of an emerging country. Although Ghana shares several characteristics with most emerging economies, which promotes a generalizable

research setting for investigating the effects of co-innovation behavior on sustainable innovation, other emerging economies may be characterized by unique and varied contextual idiosyncrasies that call for additional investigation. We suggest that the findings from the current study be evaluated in the context of an emerging market, which may not be generalizable to Western societies or more developed economies. Thus, we call for additional research to help identify how co-innovation could potentially drive sustainable innovation in other economies such as those found in North America and Europe.

Second, Ghanaian managers' perceptions may be shaped by a specific culture, customs, and (Adomako et al., 2020) and this could potentially influence the sustainable innovation activities of firms. Provided that we did not investigate the possible ways in which cultural factors may influence some of the observed variations in sustainable innovation, we call for more research to explore the influence of co-innovation on sustainable innovation by controlling for cultural factors across emerging economies. Third, we did not account for the influence of foreign direct investment (FDI) on the findings of the current study. It can be argued that more inflows of FDI could influence sustainable innovation in emerging market firms. Thus, it is suggested that future studies control for this variable to account for its effect on sustainable innovation. Finally, despite the strength of our methodology—the data were collected at two different times (time-lagged)—helping us to attenuate the potentially inflated correlations frequently associated with cross-sectional data (Podsakoff et al., 2012), the current study did not manipulate the variables or make use of random assignment techniques. Thus, we cannot make causal claims concerning the findings of the study. We suggest that future research should use experimental techniques such as random assignments.

6 | CONCLUSION

The current study used time-lagged data from 312 firms in Ghana to examine the influence of co-innovation behaviors on sustainable innovation. Further, our conceptual model outlined that absorptive capacity, a dynamic capability, helps to convert co-innovation into improved sustainable innovation if the firm operates in competitive environments. These findings contribute to two streams of research. First, it contributes to the co-innovation literature by highlighting the role of co-innovation behavior in sustainable innovation. Second, the findings contribute to the sustainable innovation literature by explaining the boundary conditions of the relationship between co-innovation and sustainable innovation.

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