R&D MANAGEMENT

The SME R&D intensity and product innovation relationship: the mediating role of quality management in the context of a developing country

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SMEs engage in product innovation despite their inherent resource constraints, lack of financial slack, and the under-development of competitively viable strategic configurations around the globe. While progress has been made in identifying the antecedents and capabilities attributed to successful innovation outcomes and the performance of these firms, there remain disparate and often paradoxical observations on the factors that affect SME innovation performance across geographies (i.e. developed vs developing countries) and operational contexts (R&D intensity and quality management practices). This study collected data from 241 resource-constrained small and medium-sized enterprises (SMEs) in a developing country (Ghana) to contribute to this debate. The results of structural equation modeling show that quality management mediates the relationship between R&D intensity and product innovation. The results also reveal the effects of knowledge integration and financial slack on the relationship between R&D intensity and product innovation, with a high level of knowledge integration enhancing the effect but a high financial slack hinders it. This study sheds light on a broader range of contextual and financial variables when seeking contingencies of SME product innovation performance within theory and practice.

1. Introduction

SME innovation activities are crucial in economic development worldwide (McCann and Ortega-Argilés, 2016). Some authors would even suggest that SMEs demonstrate more robust R&D intensity than large firms (Montresor and Vezzani, 2015), serving as the lifeblood of GDP development within regions. Yet, SME survival rates and performance remain bleak, and they struggle to achieve growth and efficiency (World Economic Forum, 2022). While scaling these businesses is laden with hurdles and challenges, research has suggested that their ability to exploit new

opportunities and accumulate knowledge to develop new products is central to their survival and growth prospects (Baptista et al., 2006; Raymond and St-Pierre, 2010). R&D-oriented SMEs boost capacity through their ability to churn out new products, while those lacking R&D capacities are more susceptible to ever-changing market fluctuations (Añón-Higón et al., 2015). The knowledge obtained from R&D intensity nurtures an organizational climate that favors the capacity to integrate new concepts and adaptability (Raymond and St-Pierre, 2010), which then enhances productivity, growth, competitiveness, and consequently innovation for their survival (Zahra and George, 2002; Añón-Higón et al., 2015). Yet, in light of global trends toward SME survival, numerous concerns remain about the effectiveness of their product innovation processes, determinants, and R&D management configurations.

Research has uncovered the direct effect of R&D intensity on product innovation (Heij et al., 2020; Medda, 2020). However, SMEs are often financially constrained (Motta, 2020) and must carefully leverage a broad range of resource stocks to develop risky and volatile R&D activities (Czarnitzki and Hottenrott, 2011). The financial limitations are even more pronounced for SMEs in developing economies' resource-constraint and weak institutional context (Abubakar et al., 2019; Masroor and Asim, 2019). This issue is exacerbated further because much of what we know about innovation emanates from firms in developed economies' stable and endowed environments (Luo et al., 2011; Amankwah-Amoah and Adomako, 2021). Developing countries are also associated with weaker legal protections (e.g. IP), bureaucratic inefficiencies, and less established policies that would encourage R&D activities. Thus, the same level of R&D activity may result in different output levels in developing and developed countries, with firm failures more likely to occur in developing countries (Özçelik and Taymaz, 2008).

The innovation outcomes of SMEs in developing countries are critical for achieving economic growth (Lee et al., 2015) and are linked to their survival potential (Zahra and George, 2002). They must develop strategic mechanisms for overcoming financial limitations to achieve their R&D objectives (Adams, 1982; Oduro, 2019; Adomako et al., 2021; Singh et al., 2022). Yet, the debate regarding the various inputs, systems, and procedures influencing R&D performance remains lively. Recently, some authors have suggested that quality management processes are core resources for developing and implementing innovation in firms (Zeng et al., 2015; Bourke and Roper, 2017; Honarpour et al., 2018). Firms that embrace quality management strive to meet the expectations of customers and are likely to be innovative in introducing new products (Hoang et al., 2006). This focus on continuous improvement encourages firms to embark on changes in the design and development of new products and services (Martinez-Costa and Martínez-Lorente, 2008). However, others have argued that this offers a constricted lens that induces firms to focus on short-term incremental adjustments while neglecting future growth and riskier opportunities (Slater and Narver, 1998). Nevertheless, the more high-quality knowledge assets are developed, the better the firms are at identifying new opportunities for innovation (Guo et al., 2020).

Quality management is a crucial underlying mechanism through which R&D intensity fosters the product innovation of SMEs, but not well understood. Therefore, our study sought to understand the effect of R&D intensity on product innovation in the underexplored context of a developing economy (Cuervo-Cazurra et al., 2018; Medda, 2020). Drawing on a moderated mediation framework (Preacher et al., 2007), we investigate the influence of quality management on the relationship between R&D intensity and product innovation outputs for SMEs. We also investigate the potential for moderation influences by examining the influence of knowledge integration and financial slack on the R&D intensity of product innovation relationships (Shaikh et al., 2018).

By testing an empirical model that elucidates both the direct and indirect effects of R&D intensity on the innovation activities of SMEs in a developing economy context, we examine the resource imperative to enhance product innovation for SMEs. SMEs in developing countries lack systemic innovation support systems found in developed countries and face numerous contextual hurdles, scarce resources, limited markets, and shortages of technical skills (Hadjimanolis and Dickson, 2001). Embedding resources at the systemic level (i.e. knowledge) should be a priority in developing countries' innovation efforts rather than just continuing with the traditional focus on production systems (Özçelik and Taymaz, 2008).

2. Theoretical background

The resource-based view (RBV) argues that knowledge is a primary intangible resource that can be harnessed to achieve robust innovation outcomes in

SMEs (Liu et al., 2022). It recognizes the importance of accumulating unique resources and capabilities to drive various performance outcomes (Barney, 1991; Barney and Clark, 2007). A firm's competitiveness is anchored on the resources it possesses, leverages, and deploys to outperform competing firms (Satta et al., 2016) that are valuable, rare, or costly to imitate (Zhao and Tan, 2021). This may include knowledge, human capital, physical assets, and other intangible and tangible assets (Grant, 1991). High-quality resources and the way they are managed fuel innovation efforts (Jin et al., 2024) and superior performance (Wu et al., 2006), Established processes such as quality management and knowledge resources are crucial for firms to develop new products and innovation ability (Sung and Choi, 2018). R&D activity helps firms accumulate and nurture the resource foundations for product innovation (Chen and Huang, 2009).

Exploring and applying valuable knowledge resources could foster the development of novel solutions and innovation in firms of all sizes. Through R&D intensity, firms can exploit knowledge resources to satisfy the diverse needs of customers and products (Amankwah-Amoah and Wang, 2019). As such, there is an imperative to understand how a resource structure can be leveraged for sustained product innovation (Liu and Atuahene-Gima, 2018; Guo et al., 2019; Escrig-Tena et al., 2021), and to unravel the influence varying contexts and variables have on the R&D intensity-product innovation relationship (Cuervo-Cazurra et al., 2018; Heij et al., 2020; Medda, 2020). Nevertheless, the observations across economies and environments remain diverse and inconsistent. Some studies suggest R&D intensity as a strong predictor of product innovation (Cuervo-Cazurra et al., 2018; Medda, 2020), while others report no meaningful relationship (Hall and Bagchi-Sen, 2002), or a curvilinear relationship (Artz et al., 2010; Heij et al., 2020), and even a negative relationship between the two variables (Coombs and Bierly III, 2006); exacerbated by the inherent contextual variations of firms (i.e. size, environment, internal configurations, and so on.) The only global consensus regarding SME innovation is the resource challenges faced when innovating and surviving.

The conflicting empirical evidence on the R&D intensity–product innovation nexus has ignited debates about the potential underlying mechanisms within SMEs (Adomako et al., 2021; Senaratne et al., 2022). Thus, while our understanding of the direct relationship between R&D intensity and product innovation has improved (Heij et al., 2020; Medda, 2020), the empirical inconsistencies warrant further examination to delineate the underlying complexities and resources that sustain R&D intensity and product innovation relationship. Despite the benefits of R&D intensity, research suggests that knowledge exploration alone may not be enough to deliver robust innovation performance—leading to suggestions for firms to harness complementary resources to maximize the benefits of R&D intensity (Prajogo and Sohal, 2006; Wang and Rafiq, 2014). Furthermore, much can be learnt about studying the phenomena in environments with less developed or accessible resource support endowments (i.e. developing countries with less infrastructure for generating innovation activities).

Quality management and product innovation are commonly viewed as distinctive but complementary resources developed by firms (Adams, 1982; Prajogo and Sohal, 2003; Hung et al., 2010). They are often embedded within an organization and used to stimulate separate but distinctive capabilities (including consistent quality performance and product innovation) (Escrig-Tena and Bou-Llusar, 2005; Escrig-Tena et al., 2021). While generally treated as separate activities quality management practices influence product innovation (Martinez-Costa and Martínez-Lorente, 2008; Zeng et al., 2015; Honarpour et al., 2018). Some even suggest that implementing a quality management system could result in mechanistic routinization and, therefore, inhibit creativity and innovation (Abrunhosa and Sá, 2008; Terziovski and Guerrero, 2014). Nevertheless, it is an effective mechanism for assessing products and meeting the needs of customers (Goetsch and Davis, 2013).

Studies into how quality management can be leveraged are predominantly biased toward developed economies with limited emphasis on developing economies (Mellahi and Eyuboglu, 2001; Mensah et al., 2012) and primarily focused on the barriers to implementation (Mensah et al., 2012). It remains unclear whether quality management could play any role in the relationship between R&D intensity and product innovation of SMEs, especially in the low-resource context of developing economies. By low-resource context, we refer to an economy that typically operates with limited access to financial, human, or technological resources compared to more developed economies. Firms within these regions often face numerous contextual challenges, such as limited infrastructure, inadequate access to capital, and a less skilled workforce, exacerbating the inherent resource limitations SMEs typically face. Nevertheless, SME product innovations emerging from these resource-constrained economies abound and the influence R&D intensity and quality

management have presents a compelling backdrop for analysis (McCann and Ortega-Argilés, 2016).

2.1. R&D intensity and product innovation of SMEs

R&D intensity influences the product innovation of SMEs in a developing economy. It enables firms to create, understand, and use knowledge (Artz et al., 2010) and thus provide the requisite ingredients for innovation (Belderbos et al., 2004; Sung and Choi, 2018) It can help SMEs modify and replace existing knowledge with new knowledge resources that can be utilized to boost the development of new products (Chen and Huang, 2009). Thus, by investing in R&D activities, SMEs can build a robust knowledge reservoir to drive innovation implementation since decisions (Zhou and Li, 2012). However, given that SMEs are resource-constrained, they can be more judicious in applying acquired resources toward these activities (Teirlinck, 2017; Guo et al., 2020). Despite this, knowledge resources derived from R&D intensity can foster continuous improvement and benefit SMEs' product innovation. This is especially so when considering developing country contexts, which are less explored (Cuervo-Cazurra et al., 2018; Medda, 2020). Therefore, we hypothesize:

H1 R&D intensity is positively related to product innovation of SMEs in a developing economy.

2.2. The mediating effect of SME quality management practices

R&D intensity expands firms' knowledge stock (Wu and Shanley, 2009) and can serve as a critical input for quality management (Prajogo and Sohal, 2006). Quality management is a vital but often overlooked knowledge mechanism for transforming R&D intensity into product innovation within SMEs. The knowledge resources derived from R&D intensity can be harnessed to enhance quality management principles such as continuous improvement and customer focus. In addition, knowledge application leads to new learning and enhanced competencies (Nonaka and Takeuchi, 1995), which can be leveraged to improve quality management and products. Thus, the knowledge resources derived from R&D intensity can be deployed to enhance quality management and serve as a precondition for increased productivity (Martinez-Costa and Martínez-Lorente, 2008).

Quality management influences product innovation (Martinez-Costa and Martínez-Lorente, 2008; Zeng et al., 2015; Bourke and Roper, 2017). It creates enabling conditions for successful innovation (Martinez-Costa and Martínez-Lorente, 2008) and embodies the necessary ingredients for innovation implementation (Perdomo-Ortiz et al., 2009). It also provides a structure for activities and processes to be moderated and managed, which enhances R&D activities, eliminates critical issues, and boosts innovation (Prajogo and Sohal, 2006). While still an emerging focal point for investigation, research has revealed the mediation effects of quality management on various organizational processes and outcomes (Kaynak, 2003). Accordingly, we predict that quality management mediates the relationship between R&D intensity and product innovation.

Accordingly, we contend that the relationship between R&D intensity and product innovation is positively enhanced by the presence of quality management practices. Hence, we propose the following hypothesis:

H2 Quality management mediates the relationship between SME R&D intensity and product innovation.

2.3. The moderating effect of knowledge integration

Knowledge integration mechanisms capture, analyze, and interpret different types of information for firm resources (De Luca et al., 2010). It consists of dispersed knowledge resources for competitive activities (Martini et al., 2017). It allows firms to acquire new external and internal knowledge stocks necessary for further development (Salunke et al., 2019) and combine past and new knowledge stocks into new capabilities (Guo et al., 2019). Knowledge integration mechanisms allow firms to share and synthesize these resources between functional units and facilitate innovation (Martini et al., 2017).

Given the knowledge-focused characteristics often implied within the nature of quality management practices, we suggest that focusing on knowledge integration mechanisms strengthens the effect of R&D intensity on quality management. In addition, the indirect effect of R&D intensity on product innovation (via quality management) is likely to be more substantial when knowledge integration is high. Therefore, we hypothesize:

H3a Knowledge integration positively moderates the relationship between R&D intensity and quality management in SMEs.

H3b Knowledge integration moderates the strength of the relationship between R&D intensity and product innovation when quality management is also present.

2.4. The moderating effect of financial slack

Financial slack is a crucial resource (Parida and Örtqvist, 2015). Unused and uncommitted financial resources can be easily applied to achieve organizational goals (Carnes et al., 2019) and allow SMEs to engage in risks, such as R&D and innovation in general (Lungeanu et al., 2016). It can help SMEs unearth novel solutions and enhance operational routines (Guo et al., 2020) while also responding to environmental fluctuations and dynamic changes (Parida and Örtqvist, 2015). In addition, financial slack ensures the provision of requisite logistics in SMEs and risks that emanate from inadequate resources (Bradley et al., 2011) (Figure 1).

In light of the preceding arguments, financial slack is likely to strengthen the effect of R&D intensity on quality management. We posit that the indirect effect of R&D intensity on product innovation (via quality management) would be stronger when financial slack is high. Accordingly, we hypothesize:

H4a Financial slack positively moderates the relationship between R&D intensity and quality management.

H4b Financial slack moderates the strength of the relationship between R&D intensity and product innovation when quality management is present.

3. Method

3.1. Research setting

This study examines resource-constrained SMEs in the developing economy of Ghana to enhance our understanding of the complex relationship between R&D intensity activities for product innovation. SMEs are essential to the Ghanaian economy as they represent 92% of registered businesses, employ more than 80% of Ghana's workforce, and contribute about 70% of Ghana's GDP (Abor and Quartey, 2010). It is considered the most accessible place to do business in the West African sub-region (WorldBank, 2018), rendering it a fertile ground for manufacturing and product development. The stable democratic dispensation and favorable business policies have made Ghana the destination of foreign direct investment (Amankwah-Amoah et al., 2018). Despite these developments, it remains classified as a developing economy with a need for further establishment of infrastructure. With a vibrant SME sector, the potential of the manufacturing sector, and the economic prospects, Ghana provides a fertile context for investigating innovation from the perspective of developing economies (Adomako et al., 2021).

3.2. Sample and data collection

We derived our sampling frame from the Ghana Revenue Authority (GRA). Before the primary data collection phase, we conducted a pilot study to test the precision of the research protocol and validate the technique. In line with this process, each element of the questionnaire section was refined to ensure greater precision in our data collection exercise. To ensure each population unit had an equal chance of inclusion in the sample and to overcome researcher bias (Bryman, 2008), we initially randomly sampled 1000 firms that were broadly classified as manufacturing-focused. To ensure that firms in our sample had likely faced challenges of survival and made efforts toward continual innovation

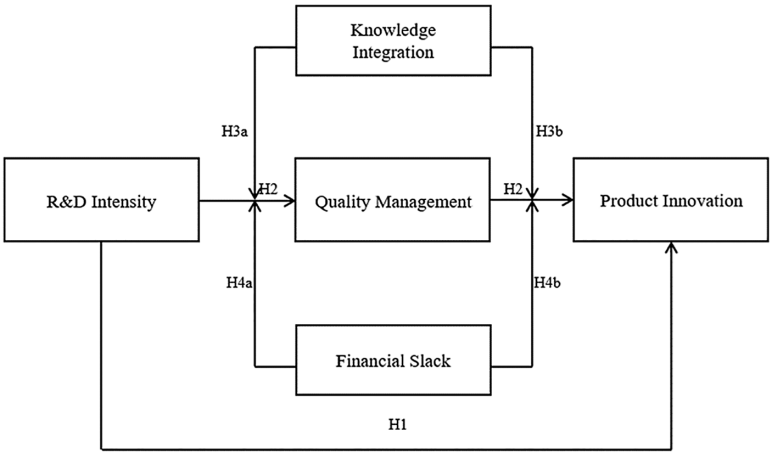

Figure 1. Research model.

rather than those at the earlier stages of their development, we then reduced our sample to include firms that followed these criteria: (i) firms with a minimum of 5 years' operating experience (García-Manjón and Romero-Merino, 2012), (ii) firms with reliable contact details (Khavul et al., 2010), (iii) firms with a minimum of five and maximum of 99 full-time employees (NBSSI, 2020), (iv) firms that manufacture physical product (Morgan et al., 2012). In the end, a total of 602 SMEs met the criteria. Using Qualtrics, the questionnaire was administered to all 602 firms. Consistent with previous research (Honarpour et al., 2018; Konadu et al., 2020), the key informants for the study were top executives such as CEOs/business owners, product development managers, finance directors, R&D managers, and marketing managers.

We adopted the multiple informants' approach to attenuate the effect of possible common method bias (CMB). Specifically, the CEOs or business owners, finance directors, and R&D managers were sampled for information on R&D intensity, financial slack, quality management, and knowledge integration. In contrast, the marketing and product development managers supplied information on product innovation. The survey yielded a total of 255 questionnaires. After discounting missing values, we obtained a total of 241 usable questionnaires. This represents a response rate of 40.03%. The average firm size was 55 full-time employees, and the average age of the firms was 14 years.

3.3. Measures

We measured multi-item constructs on a five-point Likert scale with preceding statements that indicate how the items should be rated. All the multi-item constructs were drawn from studies and provided below.

3.3.1. Product innovation

We followed Prajogo and Sohal (2006) in measuring product innovation with a scale of five items. These items capture the number of new products, the level of innovativeness, the speed of innovation, and being the 'first' in the market. Respondents were asked to report on their firms' product innovation activities in the previous 3 years against a major competitor in the industry. Research has found this approach to measuring innovation robust in many settings (Baron and Tang, 2011).

3.3.2. Quality management

To capture quality management, we used a scale from Pereira-Moliner et al. (2012). The scale consists of seven items measuring firms' fundamental quality management practices. Recent research confirms the scale's robustness (Konadu et al., 2020).

3.3.3. R&D intensity

R&D intensity was captured as a ratio of total R&D expenditure to total sales. It was obtained by dividing total expenditures on R&D by the total sales of the firms in the previous 3 years, which is the approach to measuring R&D intensity well established in the literature (Hull and Rothenberg, 2008; Padgett and Galan, 2010).

3.3.4. Financial slack

We utilized a scale from Tran et al. (2018) to measure financial slack. The scale consists of four items that capture firms' uncommitted or discretionary financial resources.

3.3.5. Knowledge integration

Following De Luca and Atuahene-Gima (2007), we tapped knowledge integration using a scale of six items. These items measure the extent to which the firms use formal integration mechanisms to capture and integrate knowledge. Recent research confirms the robustness of this scale (Amankwah-Amoah and Adomako, 2021).

3.3.6. Control variables

We controlled for firm age, firm size, and the existence of R&D units since they can influence innovation outcomes (Cui et al., 2018). Firm size was measured as the total number of full-time employees. Firm age was measured as the years since the firm was incorporated. Additionally, given that not all the sampled firms had a separate formal R&D unit, the study controlled for the availability of a formal R&D unit since it could influence the level of R&D activities and, subsequently, innovation. A dummy variable indicated whether a firm had a formal R&D unit (1 = a formal R&D unit; 0 = otherwise). The study controlled these variables to ensure the model achieved high precision.

4. Analyses

4.1. Assessment of potential biases

4.1.1. Non-response bias test

To assess the effect of non-response bias on our data, we followed established practice and compared early and late respondents based on key variables (Anderson and Eshima, 2013). The assumption is that late respondents can be likened to non-respondents (Armstrong and Overton, 1977). Overall, the t-test examination reveals no significant differences between the two groups in terms of firm age ($p = 0.52$), product

innovation ($p=0.38$), knowledge integration ($p=0.68$), firm size ($p=0.71$), financial slack ($p=0.31$), R&D intensity ($p=0.51$), R&D intensity ($p=0.62$), R&D unit ($p=0.42$), and quality management ($p=0.44$). This suggests that non-response bias was not a significant concern for our study.

4.1.2. Common method bias assessment

To eliminate the possibility of common method bias influencing our results, we employed procedural and statistical techniques to address common method bias (Podsakoff et al., 2012). The procedural measures included: (i) we adopted a multiple informant approach for the data collection (Podsakoff et al., 2012), (ii) we conducted a pilot study for further refinement (Hussey and Hussey, 1997), (iii) we implemented the proximal separation of the scales (Podsakoff et al., 2003).

Statistically, we first performed Harman's one-factor test (Podsakoff et al., 2003). After loading all the items on a single factor in exploratory factor analysis with principal axis factoring, the first factor explains only 21.5% of the variance for all items. This suggests that no single factor was dominant, so common method bias was not a significant concern (Podsakoff and Organ, 1986). Second, we utilized the common latent factor technique to assess common method bias. To achieve this, we estimated two competing CFA models. In Model 1, each indicator loaded in on its respective latent factor, and the results reveal a good fit to the data: $x^2=296.87$; $x^2/df=1.48$; RMSEA = 0.04; GFI = 0.90; IFI = 0.96 and CFI = 0.96. We replicated the same process for Model 2 except for including a common latent factor estimated to load on all the indicators. By this, we controlled for any variance resulting from a common source. The results in Model 2 also show a good fit: $x^2=296.61$; $x^2/df=1.48$; RMSEA = 0.04; GFI = 0.90; IFI = 0.96 and CFI = 0.96. A comparison of the two models reveals no significant difference; thus, Model 2 is not substantially better than Model 1. This suggests that common method bias was not a significant concern.

4.1.3. Validity and reliability assessment

Using the maximum likelihood estimation method in AMOS 28.0, we performed a confirmatory factor analysis (CFA) to establish the reliability and validity of the multi-item constructs. The CFA produced a good fit between the hypothesized structural model and the observed data: $x^2/df=1.48$; RMSEA = 0.04; GFI = 0.90; IFI = 0.96; RMR = 0.06 and CFI = 0.96. As shown in Table 1, the standardized factor loadings for all the items are significant, supporting convergent validity (Fornell and Larcker, 1981). Moreover, Cronbach's alpha values for all the multi-item constructs exceed the recommended threshold of 0.70 for confirmatory research (Nunnally and Bernstein, 1994). This demonstrates adequate reliability (Cronbach, 1951). In addition, the average variance extracted (AVE) values for all the constructs meet the recommended threshold of 0.50 (Fornell and Larcker, 1981). Further, as shown in Table 1, the composite reliability (CR) values for all the constructs exceed the recommended threshold of 0.60 for model testing (Hayduk, 1987). This suggests that the constructs of the study demonstrate adequate convergent validity (Fornell and Larcker, 1981). Finally, to establish discriminant validity, we followed established practice and calculated the square roots of the AVEs for all the multi-item constructs. As shown in Table 2, the constructs demonstrate discriminant validity (Fornell and Larcker, 1981).

Interestingly, a negative correlation between R&D unit and R&D intensity was observed within our data set. Intuitively, it was expected that firms with dedicated formal R&D units would have a higher R&D activity than those without. Given that SMEs are resource-constrained, particularly in our research context (Abubakar et al., 2019), and perhaps narrowly defined around a limited scope of product innovation activities, it could be that R&D units are not defined in a unanimous way or in the traditional sense amongst these firms and explains the counter-intuitive observation.

4.2. Structural model estimation

To test the hypothesized structural relationships presented in the conceptual model, we employed structural equation modeling (SEM) and maximum likelihood (ML) estimation to test a system of nested structural models in path analysis in AMOS 28.0. Following precedence (Donbesuur et al., 2022), we created composite scores for the multi-item constructs to obtain single indicants. However, we utilized the full information approach for the dependent variables (quality management and product innovation). This was necessary to eliminate potential model under-identification (Hair Jr et al., 2017). To evaluate the moderation paths, we created interaction terms. The variables involved in the interaction were mean-centered before the interaction terms were created to correct multicollinearity (Aiken and West, 1991). Beyond the mean-centering approach, the most significant variable inflation factor (VIF) was 2.15, well below the recommended threshold of 10 (Neter et al., 1996). Hence, we find no sign of multicollinearity.

In all, nine nested structural models were estimated. The dependent variable in Models 1–4 is

Table 1. Construct validity and reliability

Constructs/items	Factor loadings	Cronbach alpha	AVE	CR
Product Innovation		0.88	0.60	0.88
1	0.78			
2	0.70			
3	0.81			
4	0.81			
5	0.77			
Quality Management		0.90	0.54	0.89
1	0.67			
2	0.60			
3	0.81			
4	0.78			
5	0.83			
6	0.74			
7	0.67			
Knowledge Integration		0.85	0.50	0.85
1	0.72			
2	0.76			
3	0.68			
4	0.72			
5	0.64			
6	0.66			
Financial Slack		0.78	0.51	0.80
1	0.69			
2	0.77			
3	0.69			
4	0.68			

Fit Indices: $x^2 = 296.87$; $df = 201$; $x^2/df = 1.48$; RMSEA = 0.04; GFI = 0.90; IFI = 0.96; RMR = 0.06; CFI = 0.96.

Table 2. Discriminant validity assessment

Constructs	PRINNO	QLMGT	INTGR	SLACK
PRINNO	0.78			
QLMGT	0.33	0.74		
INTGR	−0.11	−0.11	0.70	
SLACK	0.06	−0.02	0.05	0.71

quality management. Model 1 estimated the effects of the control variables on quality management. In Model 2, the effect of the independent variable (R&D intensity) was added. Model 3 estimated the effect of one interaction term (R&D intensity × knowledge integration), while the other interaction term (R&D intensity × financial slack) was assessed in Model

Table 3. Descriptive statistics and correlation matrix

Variables	Mean	SD	1	2	3	4	5	6	7	8
1. Firm size (employees)	55.15	25.57	1.00							
2. Firm age (years)	13.64	5.21	0.15*	1.00						
3. R&D unit	1.39	0.49	0.06	0.02	1.00					
4. Quality management	3.62	0.99	−0.05	−0.06	−0.03	1.00				
5. Knowledge integration	3.84	0.69	−0.01	−0.02	0.19**	0.09	1.00			
6. Financial slack	3.56	0.82	0.02	0.02	0.08	−0.02	0.05	1.00		
7. R&D intensity	0.81	0.03	−0.10	−0.05	−0.07	0.19**	0.04	−0.16*	1.00	
8. Product innovation	4.21	0.70	0.03	0.02	0.01	0.30**	0.10	0.05	0.22**	1.00

$N = 241$.
R&D, research and development; SD, standard deviation.
*$p < 0.05$; **$p < 0.01$ (2-tailed test);

4. In Models 5–9, the dependent variable is product innovation. Model 5 estimated the effect of the control variables on product innovation. Model 6 tested the direct effect of R&D intensity, while Model 7 estimated the effect of quality management on product innovation. Model 8 assessed the effect of one interaction term (quality management × knowledge integration), and finally, Model 9 estimated the effect of the other interaction term (quality management × financial slack). The results of the structural model estimation are presented in Table 4.

5. Results

The means, standard deviations, and correlations for all the variables are reported in Table 3. The results of the hypotheses testing are presented in Table 4. Hypothesis 1 posits that R&D intensity is positively related to product innovation of SMEs in a developing economy. As shown in Model 6, R&D intensity is indeed positively related to product innovation of SMEs ($\beta = 0.24$; $t = 3.47$; $p < 0.01$). Thus, the study finds support for H1. Hypothesis 2 contends that quality management mediates the effect of R&D intensity on product innovation. As the results in Table 4 show, we find support for this. Specifically, as shown in Model 6, R&D intensity is significantly related to product innovation ($\beta = 0.24$, $t = 3.47$, $p < 0.01$). Second, as shown in Model 2, R&D intensity is significantly related to quality management ($\beta = 0.19$, $t = 2.86$, $p < 0.01$). In turn, as the results in Model 7 show, quality management is significantly related to product innovation ($\beta = 0.29$, $t = 4.27$, $p < 0.01$). Importantly, as illustrated in Model 7, the significant positive effect of R&D intensity on product innovation ($\beta = 0.24$; $t = 3.47$; $p < 0.01$) declines but remains significant when R&D intensity's effect on product innovation is channeled through quality management ($\beta = 0.18$, $t = 2.77$, $p < 0.01$), thus signaling the presence of partial mediation. Hence, H2 is supported.

Hypothesis 3a argues that knowledge integration positively moderates the relationship between R&D intensity and quality management. As Model 4 shows, we find support for H3a, as knowledge integration enhances the relationship between R&D intensity and quality management ($\beta = 0.13$, $t = 2.18$, $p < 0.05$). Hypothesis 3b posits that the indirect effect of R&D intensity on product innovation through quality management is strengthened when knowledge integration is high. To evaluate this, we utilized PROCESS macro (Model 75) (Hayes, 2013) to estimate the conditional indirect effects at one standard deviation below the mean, at the mean, and above the mean score of knowledge integration. The results show that the indirect effect is stronger (3.22) and significant (CI excludes zero) when knowledge integration is high (CI = 0.51–7.08). However, the indirect effect is weaker (0.01) and non-significant (CI includes zero) when knowledge integration is low (CI = −0.54 to 0.53). These results provide support for H3b. A summary of the moderated mediation analysis is presented in Table 5.

To further enhance the interpretation of the moderating effect, we followed Cohen et al.'s (2014) recommendation and created interaction plots to illustrate the conditional effect of knowledge integration. As illustrated by the surface plot in Figure 2, the indirect effect of R&D intensity on product innovation is stronger when knowledge integration is high.

Hypothesis 4a predicts that financial slack positively moderates the relationship between R&D intensity and quality management. Contrary to the prediction, we find no support for H4a as the structural path in Model 4 reveals a non-significant coefficient ($\beta = -0.04$, $t = -0.61$, $p > 0.05$). Hence, H4a is not supported. Hypothesis 4b contends that the indirect effect of R&D intensity on product innovation through quality management is strengthened when financial slack is high. Using PROCESS macro (Model 75), we tested the conditional indirect effects at one standard deviation below the mean, at the mean, and above the mean score of financial slack. Contrary to the prediction, the indirect effect is weaker (0.28) and non-significant when financial slack is high (CI = −0.47 to 1.86) but stronger (1.86) though non-significant (CI = −0.01 to 4.11) at a low level of financial slack. This suggests that a high level of financial slack dampens the indirect effect of R&D intensity on product innovation. Hence, H4b is not supported. A summary of the results is presented in Table 6.

To provide additional insight into the moderating effect, interaction plots were created to illustrate the varying effects of financial slack on the indirect effect of R&D intensity on product innovation. As displayed in Figure 3, the indirect effect on product innovation weakens when financial slack is high.

5.1. Further analyses

First, to establish the robustness of the mediation analysis, we utilized PROCESS macro (Model 4) (Hayes, 2013) to confirm the initial SEM results. The results show that R&D intensity is positively and significantly related to product innovation

Table 4. Results of structural model estimation

	Dependent variables								
	Models 1–4: Quality management				Models 5–9: Product innovation				
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Firm size	−0.04 (−0.56)	−0.02 (−0.29)	−0.05 (−0.66)	−0.04 (−0.62)	0.03 (0.45)	0.05 (0.79)	0.06 (0.91)	0.07 (1.01)	0.07 (1.13)
Firm age	−0.06 (−0.84)	−0.05 (−0.76)	−0.07 (−0.99)	−0.07 (−1.03)	0.02 (0.24)	0.03 (0.38)	0.04 (0.57)	0.03 (0.44)	0.01 (0.23)
R&D unit	−0.04 (−0.61)	−0.03 (−0.45)	−0.00 (−0.01)	−0.01 (−0.09)	0.01 (0.15)	0.02 (0.36)	0.03 (0.46)	0.04 (0.69)	0.04 (0.68)
Direct effects									
R&D Intensity (RDI)		0.19 (2.86)**	0.19 (2.89)**	0.20 (2.92)**		0.24 (3.47)**	0.18 (2.77)**	0.15 (2.36)*	0.17 (2.59)**
Quality Management (QM)							0.29 (4.27)**	0.20 (2.97)**	0.22 (3.21)**
Knowledge Integration (KI)			0.14 (2.24)*	0.14 (2.23)*				0.12 (1.86)	0.10 (1.57)
Financial Slack (FS)				0.04 (0.62)					0.09 (1.34)
Interaction effects									
RDI × KI			0.14 (2.20)*	0.13 (2.18)*					
RDI × FS				−0.04 (−0.61)					
QM × KI								0.23 (3.34)**	0.18 (2.47)*
QM × FS									−0.16 (−2.37)*
Model fit indices									
x^2/df	4.32	4.03	3.51	2.94	1.04	1.05	1.31	1.43	1.28
RMSEA	0.12	0.11	0.10	0.09	0.01	0.01	0.04	0.04	0.03
GFI	0.88	0.90	0.90	0.91	0.98	0.98	0.96	0.97	0.97
NFI	0.86	0.85	0.93	0.96	0.97	0.97	0.95	0.94	0.94
TLI	0.85	0.83	0.92	0.95	0.99	0.99	0.98	0.96	0.97
CFI	0.89	0.88	0.95	0.97	0.99	0.99	0.99	0.98	0.98

N=241.
*p<0.05; **p<0.01; Standardized coefficients are shown; t – values are reported in parentheses.

Table 5. Conditional indirect effects on product innovation across levels of knowledge integration

Knowledge integration	Indirect effect	LLCI 95%	ULCI 95%
Low (−1SD) = −0.69	0.01	−0.54	0.53
High (+1SD) = 0.69	3.22	0.51	7.08

N = 241; Bootstrap sample size = 5000.
LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

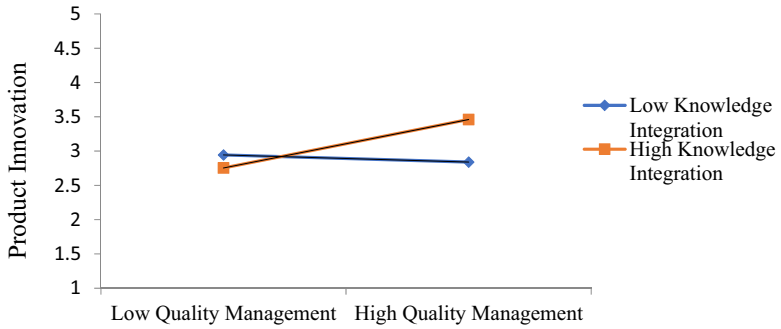

Figure 2. Surface plot of the moderating effect of knowledge integration.

Table 6. Conditional indirect effects on product innovation across levels of financial slack

Financial slack	Indirect effect	LLCI 95%	ULCI 95%
Low (−1SD) = −0.82	1.86	−0.01	4.11
High (+1SD) = 0.82	0.28	−0.47	1.86

N = 241; Bootstrap sample size = 5000.
LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

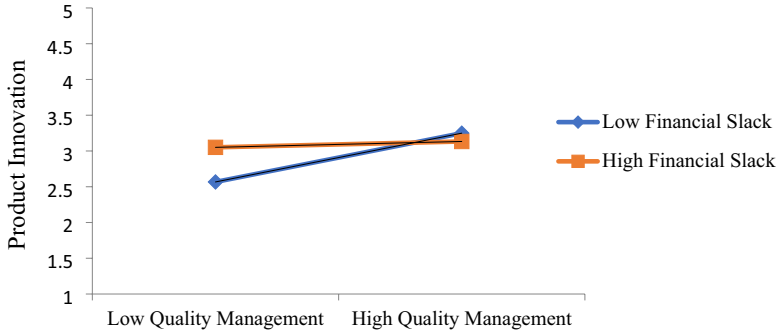

Figure 3. Surface plot of the moderating effect of financial slack.

($\beta = 0.23$, $t = 3.58$, $p < 0.01$). This confirms the initial SEM results for H1. In addition, R&D intensity is positively and significantly related to quality management ($\beta = 0.18$, $t = 2.86$, $p < 0.01$). In turn, quality management positively relates to product innovation ($\beta = 0.28$, $t = 4.44$, $p < 0.01$). Moreover, with the introduction of quality management, the effect size of R&D intensity on product innovation declines but remains significant ($\beta = 0.18$, $t = 2.84$, $p < 0.01$), indicating partial mediation. Importantly, we further estimated the significance of the indirect effect and found a corresponding lower bound of 0.13 and upper bound of 2.92 using a bootstrap-estimated 95% confidence interval. Given that the 95% confidence interval results exclude zero, the indirect effect of R&D intensity on product innovation through quality management is significant. However, given that the direct effect of R&D intensity on product innovation attenuates but remains significant, it is concluded that quality management partially mediates the relationship between R&D intensity and product innovation. This provides additional support for H2. The significance of the indirect effect is presented in Table 7.

As an additional robustness measure, we tested for a curvilinear relationship between R&D intensity and product innovation. The analysis reveals

Table 7. Significance of the indirect effect

Relationship	Direct effect	Indirect effect	LLCI 95%	ULCI 95%	Conclusion
R&D Intensity → Quality Management → Product Innovation	4.12 (0.0049)	1.18	0.13	2.92	Partial Mediation

$N = 241$; Bootstrap sample size = 5000.
LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

a non-significant coefficient ($\beta = -0.09$, $t = -1.44$, $p > 0.05$). Further, we used PROCESS macro (Model 75) to estimate the moderating effects of financial slack and knowledge integration on the R&D intensity and quality management relationship. We find that the results are consistent with the initial SEM results for H3a and H4a. We utilized the SEM approach to evaluate the moderating effects of knowledge integration and financial slack on the indirect effect of R&D intensity on product innovation. As shown in Model 9, the structural path between the interaction term (QM × KI) and product innovation reveals a positive and significant coefficient ($\beta = 0.18$, $t = 2.47$, $p < 0.05$). Thus, 3b received support. However, as shown in Model 9, the structural path for the interaction term (QM × FS) and product innovation shows a negative and significant coefficient ($\beta = -0.16$, $t = -2.37$, $p < 0.05$), suggesting that financial slack negatively moderates the indirect effect of R&D intensity on product innovation. Hence, H4b is not supported. These SEM results confirm the initial PROCESS macro analysis for H3b and H4b.

A particular concern when running the model was that the R&D intensity value of 0.81 and a standard deviation of 0.03 could suggest insufficient variability across the firms in the sample. As a result, we transformed the R&D intensity and tested it with the primary dependent variable in a separate analysis. Overall, the results of the analyses are consistent with the initial results. With this, we believe the issue of low variability is not a significant concern.

6. Discussion and implications

R&D intensity is an essential driver of product innovation (Cuervo-Cazurra et al., 2018; Medda, 2020). However, how and under what conditions R&D intensity contributes to product innovation of SMEs in a developing economy still needs to be explored. Accordingly, we investigated the underlying mechanism through which R&D intensity contributes to product innovation and contend that quality management acts as the transformative mechanism that drives product innovation of these SMEs Additionally, given the resource-constrained environment of a developing economy, we further examine the extent to which the relationship between R&D intensity and product innovation through quality management is conditional on varying levels of financial slack and knowledge integration. This was to establish when the innovation-enhancing effect of R&D intensity via quality management is most beneficial to SMEs in a developing economy. Drawing on empirical data from SMEs in Ghana's manufacturing sector, we find that the effect of R&D intensity on product innovation is mediated by quality management. We show an indirect effect of R&D intensity on product innovation is amplified when knowledge integration is high. In contrast, a high financial slack hinders the indirect effect on product innovation.

6.1. Theoretical implications

Our findings show that quality management is a vital transformative mechanism through which R&D intensity influences product innovation. It shows that R&D intensity alone is an insufficient explanation for the effectiveness of product innovation outputs. We reveal that SMEs who transform knowledge resources from R&D intensity into exploitable quality management routines enhance product innovation. Therefore, the debates on the R&D intensity and product innovation linkage should consider a broader range of causal mechanisms. We contribute insights by validating the role quality management practices have as intermediate mechanisms through which R&D intensity influences product innovation (Heij et al., 2020; Medda, 2020) and the relationships proposed in the ongoing theoretical debates (i.e. Bourke and Roper, 2017; Heij et al., 2020; Adomako et al., 2021).

Second, while the role of R&D intensity in firm outcomes has been studied extensively (Ruiqi et al., 2017; Cuervo-Cazurra et al., 2018; Adomako et al., 2021), the conditions under which it is effective in driving product innovation through quality management remain less established. We demonstrate that the indirect effect of R&D intensity on product innovation is enhanced when SMEs in developing countries show high levels of knowledge integration. In contrast, a high

level of financial slack hampers the indirect effect. While the role of financial slack in R&D activities is not in doubt, financial slack induces inefficient behavior and wasteful spending (Guo et al., 2020). Firms in developing economies operate in an environment marked by unique cultural, political, economic, and organizational factors (Julian and Ofori-dankwa, 2013). These distinctive characteristics, such as underdeveloped institutions, financial survival culture, and unfavorable business conditions, constrain the extent to which managers of SMEs in a developing economy can apply slack resources to optimize firm-level outcomes and tend to prioritize capital retention rather than spending more on discretionary operations (Julian and Ofori-dankwa, 2013; Boso et al., 2017). Our findings also extend insight into the role knowledge integration (Guo et al., 2019; Amankwah-Amoah and Adomako, 2021) and financial slack (Tran et al., 2018; Guo et al., 2020) play in this relationship to suggest further contingencies in a low-resource context (Berchicci, 2013; Heij et al., 2020; Amankwah-Amoah and Adomako, 2021).

R&D intensity drives quality management across firms in both developed and developing economies (Padgett and Galan, 2010; Ruiqi et al., 2017). By showing that the knowledge resources derived from R&D activities are crucial drivers of the fundamental elements of quality management, SMEs must integrate techniques to develop different forms of resource for innovation beyond resource intensity alone, that is, evidence-based decision-making, customer focus, and continuous improvement (Agarwal et al., 2013; Konadu et al., 2020).

Overall, except for our counter-intuitive observation on financial slack, the study's findings are broadly consistent with studies of the context of developed countries (a high resource context) (Raymond and St-Pierre, 2010; Heij et al., 2020; Medda, 2020). Similarly, our findings on knowledge integration align with insights from developed economies (Martini et al., 2017; Malerba and McKelvey, 2020) and emphasize its importance for innovation activities. Interestingly, financial slack hinders product innovation outcomes in our context, which varies from findings of developed country contexts and the crucial role it plays (Parida and Örtqvist, 2015). Unlike previous research from developed countries which have investigated the effects of R&D activities (Heij et al., 2020; Medda, 2020) and quality management (Zeng et al., 2015; Bourke and Roper, 2017), our study provides a new perspective on precisely what effect R&D intensity and quality management have on product innovation in combination. This combination in a developing country context provides a holistic picture of the R&D resources and the product innovation nexus.

6.2. Practical implications

Given the crucial role of SMEs in national development (McCann and Ortega-Argilés, 2016), governments can develop an enabling environment for the growth and survival of SMEs in economic development plans. For example, through policy initiatives, governments can promote R&D intensity in SMEs by providing R&D support through subsidies, incentives, and grants. Yet, our findings suggest that this is not enough. The government should support SMEs in adopting and developing broader skills to accelerate innovation and promote survival (i.e. quality management initiatives such as ISO and TQM and knowledge integration best practices).

Our study provides valuable guidelines for SME managers on how and when R&D intensity contributes to product innovation. The discovery that quality management mediates the relationship between R&D intensity and product innovation suggests that managers should invest in developing quality management capabilities to deliver robust product innovation/effective R&D. It is an essential driver of the innovation-enhancing effect of R&D intensity.

The effects of knowledge integration and financial slack suggest that managers should focus not only on R&D intensity but also endeavor to nurture other innovation-enhancing mechanisms for achieving robust innovation (i.e. information exchange meetings, project committees, and formal project reviews) to boost innovation outcomes. Thus, we show that R&D intensity alone is not enough to deliver sustainable innovation. Hence, managers should be aware that a high level of financial slack hinders the indirect effect of R&D intensity on product innovation. Therefore, managers of SMEs should judiciously commit financial slack to the much-needed areas of the firm, given that it can be detrimental to firm outcomes if not well managed.

6.3. Limitations and future research directions

This study's limitations provide avenues for future research. While Ghana offers a compelling context, it would be interesting to replicate the research model in the context of other developing economies and test the model in different industrial and cultural contexts. Our data collection limited the generalizability to other developing economies. Also, future research can employ a time separation between the independent and dependent variables to observe the long-term

causal link in the relationship to unravel deeper insights. While we adopted a multiple-informant approach, the potential for common method bias may arise due to the cross-sectional nature of our data. Additionally, this study only investigates the mediating effect of quality management in the relationship between R&D intensity and product innovation. However, as illustrated by recent research (Adomako et al., 2021), other factors may underlie the relationship and are worth exploring. For example, future research could extend our study by modeling how the organic and mechanistic elements independently mediate the effect of R&D intensity on product innovation. Additional moderators, such as market orientation, human resource slack, and government subsidies on the relationship, could exist as well.

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Conflict of interest statement

There are no conflicts of interest.

Data Availability Statement

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

Özçelik, E. and Taymaz, E. (2008) R&D support programs in developing countries: the Turkish experience. *Research Policy*, **37**, 2, 258–275.

Añón-Higón, D., Manjón-Antolin, M., Mañez, J.A., and Sanchis-Llopis, J.A. (2015) Does R&D protect SMEs from the hardness of the cycle? Evidence from Spanish SMEs (1990–2009). *International Entrepreneurship and Management Journal*, **11**, 361–376.

Abor, J. and Quartey, P. (2010) Issues in SME development in Ghana and South Africa. *International Research Journal of Finance and Economics*, **39**, 6, 215–228.

Abrunhosa, A., Moura, E., and Sá, P. (2008) Are TQM principles supporting innovation in the Portuguese footwear industry? *Technovation*, **28**, 4, 208–221. https://doi.org/10.1016/j.technovation.2007.08.001.

Abubakar, Y.A., Hand, C., Smallbone, D., and Saridakis, G. (2019) What specific modes of internationalization influence SME innovation in sub-Saharan least developed countries (LDCs)? *Technovation*, **79**, 56–70.

Adams, A. (1982) Barriers to product innovation in small firms: policy implications. *European Small Business Journal*, **1**, 1, 67–86.

Adomako, S., Amankwah-Amoah, J., Danso, A., Danquah, J.K., Hussain, Z., and Khan, Z. (2021) R&D intensity, knowledge creation process, and new product performance: the mediating role of international R&D teams. *Journal of Business Research*, **128**, 719–727.

Agarwal, R., Green, R., Brown, P.J., Tan, H., and Randhawa, K. (2013) Determinants of quality management practices: an empirical study of New Zealand manufacturing firms. *International Journal of Production Economics*, **142**, 1, 130–145.

Aiken, L.S. and West, S.G. (1991) *Multiple regression: testing and interpreting interactions*. Newbury Park, CA: Sage.

Amankwah-Amoah, J. and Adomako, S. (2021) The effects of knowledge integration and contextual ambidexterity on innovation in entrepreneurial ventures. *Journal of Business Research*, **127**, 312–321.

Amankwah-Amoah, J., Boso, N., and Antwi-Agyei, I. (2018) The effects of business failure experience on successive entrepreneurial engagements: an evolutionary phase model. *Group & Organization Management*, **43**, 4, 648–682.

Amankwah-Amoah, J. and Wang, X. (2019) Business failures around the world: emerging trends and new research agenda. *Journal of Business Research*, **98**, 367–369.

Anderson, B.S. and Eshima, Y. (2013) The influence of firm age and intangible resources on the relationship between entrepreneurial orientation and firm growth among Japanese SMEs. *Journal of Business Venturing*, **28**, 3, 413–429.

Armstrong, J.S. and Overton, T.S. (1977) Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, **14**, 3, 396–402.

Artz, K.W., Norman, P.M., Hatfield, D.E., and Cardinal, L.B. (2010) A longitudinal study of the impact of R&D, patents, and product innovation on firm performance. *Journal of Product Innovation Management*, **27**, 5, 725–740.

Baptista, N.M., Annansingh, F., Eaglestone, B., and Wakefield, R. (2006) Knowledge management issues in knowledge-intensive SMEs. *Journal of Documentation*, **62**, 1, 101–119.

Barney, J. (1991) Firm resources and sustained competitive advantage. *Journal of Management*, **17**, 1, 99–120.

Barney, J.B. and Clark, D.N. (2007) *Resource-based theory: creating and sustaining competitive advantage*. Oxford: Oxford University Press. Available from: https://ebookcentral.proquest.com/lib/durham/detail.action?docID=415721. [accessed 13th June 2021]

Baron, R.A. and Tang, J. (2011) The role of entrepreneurs in firm-level innovation: joint effects of positive affect, creativity, and environmental dynamism. *Journal of Business Venturing*, **26**, 1, 49–60.

Belderbos, R., Carree, M., and Lokshin, B. (2004) Cooperative R&D and firm performance. *Research Policy*, **33**, 10, 1477–1492.

Berchicci, L. (2013) Towards an open R&D system: internal R&D investment, external knowledge acquisition, and innovative performance. *Research Policy*, **42**, 1, 117–127.

Boso, N., Danso, A., Leonidou, C., Uddin, M., Adeola, O., and Hultman, M. (2017) Does financial resource slack drive sustainability expenditure in developing economy small and medium-sized enterprises? *Journal of Business Research*, **80**, 247–256.

Bourke, J. and Roper, S. (2017) Innovation, quality management and learning: short-term and longer-term effects. *Research Policy*, **46**, 8, 1505–1518.

Bradley, S.W., Shepherd, D.A., and Wiklund, J. (2011) The importance of slack for new organizations facing 'tough environments'. *Journal of Management Studies*, **48**, 5, 1071–1097.

Bryman, A. (2008) *Social research methods, edn*. Oxford: Oxford University Press.

Carnes, C.M., Xu, K., Sirmon, D.G., and Karadag, R. (2019) How competitive action mediates the resource slack–performance relationship: a meta-analytic approach. *Journal of Management Studies*, **56**, 1, 57–90.

Chen, C.-J. and Huang, J.-W. (2009) Strategic human resource practices and innovation performance—the mediating role of knowledge management capacity. *Journal of Business Research*, **62**, 1, 104–114.

Cohen, P., West, S.G., and Aiken, L.S. (2014) *Applied multiple regression/correlation analysis for the behavioral sciences*. New York, NY: Psychology Press.

Coombs, J.E. and Bierly, P.E., III (2006) Measuring technological capability and performance. *R&D Management*, **36**, 4, 421–438.

Cronbach, L.J. (1951) Coefficient alpha and the internal structure of tests. *Psychometrika*, **16**, 3, 297–334.

Cuervo-Cazurra, A., Nieto, M.J., and Rodríguez, A. (2018) The impact of R&D sources on new product development: sources of funds and the diversity versus control of knowledge debate. *Long Range Planning*, **51**, 5, 649–665.

Cui, T., Wu, Y., and Tong, Y. (2018) Exploring ideation and implementation openness in open innovation projects: IT-enabled absorptive capacity perspective. *Information & Management*, **55**, 5, 576–587.

Czarnitzki, D. and Hottenrott, H. (2011) R&D investment and financing constraints of small and medium-sized firms. *Small Business Economics*, **36**, 1, 65–83.

De Luca, L.M. and Atuahene-Gima, K. (2007) Market knowledge dimensions and cross-functional collaboration: examining the different routes to product innovation performance. *Journal of Marketing*, **71**, 1, 95–112.

De Luca, L.M., Verona, G., and Vicari, S. (2010) Market orientation and R&D effectiveness in high-technology firms: an empirical investigation in the biotechnology industry. *Journal of Product Innovation Management*, **27**, 3, 299–320.

Donbesuur, F., Hultman, M., Oghazi, P., and Boso, N. (2022) External knowledge resources and new venture success in developing economies: leveraging innovative opportunities and legitimacy strategies. *Technological Forecasting and Social Change*, **185**, 122034.

Escrig-Tena, A.B. and Bou-Llusar, J.C. (2005) A model for evaluating organizational competencies: an application in a quality management initiative context. *Decision Sciences*, **36**, 2, 221–257.

Escrig-Tena, A.B., Segarra-Ciprés, M., and Garcia-Juan, B. (2021) Incremental and radical product innovation capabilities in a quality management context: exploring the moderating effects of control mechanisms. *International Journal of Production Economics*, **232**, 107994.

Fornell, C. and Larcker, D.F. (1981) Structural equation models with unobservable variables and measurement error: algebra and statistics. *Journal of Marketing Research*, **18**, 382–388.

García-Manjón, J.V. and Romero-Merino, M.E. (2012) Research, development, and firm growth. Empirical evidence from European top R&D spending firms. *Research Policy*, **41**, 6, 1084–1092.

Goetsch, D. and Davis, S. (2013) *Quality management for organizational excellence, Pearson new international edition*, 7th edn. London, UK: Pearson.

Grant, R.M. (1991) The resource-based theory of competitive advantage: implications for strategy formulation. *California Management Review*, **33**, 3, 114–135.

Guo, F., Zou, B., Zhang, X., Bo, Q., and Li, K. (2020) Financial slack and firm performance of SMEs in China: moderating effects of government subsidies and market-supporting institutions. *International Journal of Production Economics*, **223**, 107530.

Guo, R., Cai, L., and Fei, Y. (2019) Knowledge integration methods, product innovation, and high-tech new venture performance in China. *Technology Analysis & Strategic Management*, **31**, 3, 306–318.

Hadjimanolis, A. and Dickson, K. (2001) Development of national innovation policy in small developing countries: the case of Cyprus. *Research Policy*, **30**, 5, 805–817.

Hair, J.F., Jr., Babin, B.J., and Krey, N. (2017) Covariance-based structural equation modeling in the Journal of Advertising: review and recommendations. *Journal of Advertising*, **46**, 1, 163–177.

Hall, L.A. and Bagchi-Sen, S. (2002) A study of the Canadian biotechnology industry's R&D, innovation, and business performance. *Technovation*, **22**, 4, 231–244.

Hayduk, L.A. (1987) *Structural equation modeling with LISREL: essentials and advances*. Baltimore: John Hopkins Press Press.

Hayes, A.F. (2013) The PROCESS macro for SPSS and SAS (version 2.13) [Software].

Heij, C.V., Volberda, H.W., Van den Bosch, F.A., and Hollen, R.M. (2020) How to leverage the impact of R&D on product innovation? The moderating effect of management innovation. *R&D Management*, **50**, 2, 277–294.

Honarpour, A., Jusoh, A., and Md Nor, K. (2018) Total quality management, knowledge management, and innovation: an empirical study in R&D units. *Total Quality Management & Business Excellence*, **29**, 7–8, 798–816.

Hull, C.E. and Rothenberg, S. (2008) Firm performance: the interactions of corporate social performance with innovation and industry differentiation. *Strategic Management Journal*, **29**, 7, 781–789.

Hung, R.Y.-Y., Lien, B.Y.-H., Fang, S.-C., and McLean, G.N. (2010) Knowledge as a facilitator for enhancing innovation performance through total quality management. *Total Quality Management & Business Excellence*, **21**, 4, 425–438. https://doi.org/10.1080/14783361003606795.

Hussey, J. and Hussey, R. (1997) *Business research: a practical guide for undergraduate and postgraduate students*. United Kingdom: Macmillan Press Ltd.

Jin, S., Wang, J., and Zhu, P. (2024) Environmental scanning, resource orchestration, and disruptive innovation. *R&D Management*. https://doi.org/10.1111/radm.12681

Julian, S.D. and Ofori-dankwa, J.C. (2013) Financial resource availability and corporate social responsibility expenditures in a sub-Saharan economy: the institutional difference hypothesis. *Strategic Management Journal*, **34**, 11, 1314–1330.

Kaynak, H. (2003) The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management*, **21**, 4, 405–435.

Khavul, S., Pérez-Nordtvedt, L., and Wood, E. (2010) Organizational entrainment and international new ventures from emerging markets. *Journal of Business Venturing*, **25**, 1, 104–119.

Konadu, R., Owusu-Agyei, S., Lartey, T.A., Danso, A., Adomako, S., and Amankwah-Amoah, J. (2020) CEOs' reputation, quality management, and environmental innovation: the roles of stakeholder pressure and resource commitment. *Business Strategy and the Environment*, **29**, 6, 2310–2323.

Lee, R.P., Özsomer, A., and Zhou, K.Z. (2015) Introduction to the special issue on "innovation in and from emerging economies". *Industrial Marketing Management*, **50**, 16–17.

Liu, A., Gu, J., and Liu, H. (2022) The fit between firm capability and business model for SME growth: a resource orchestration perspective. *R&D Management*, **52**, 670–684. https://doi.org/10.1111/radm.12513.

Liu, W. and Atuahene-Gima, K. (2018) Enhancing product innovation performance in a dysfunctional competitive environment: the roles of competitive strategies and market-based assets. *Industrial Marketing Management*, **73**, 7–20.

Lungeanu, R., Stern, I., and Zajac, E.J. (2016) When do firms change technology-sourcing vehicles? The role of poor innovative performance and financial slack. *Strategic Management Journal*, **37**, 5, 855–869.

Luo, Y., Sun, J., and Wang, L.S. (2011) Emerging economy copycats: capability, environment, and strategy. *Academy of Management Perspectives*, **25**, 37–56.

Malerba, F. and McKelvey, M. (2020) Knowledge-intensive innovative entrepreneurship integrating Schumpeter, evolutionary economics, and innovation systems. *Small Business Economics*, **54**, 2, 503–522.

Martinez-Costa, M. and Martínez-Lorente, A.R. (2008) Does quality management foster or hinder innovation? An empirical study of Spanish companies. *Total Quality Management*, **19**, 3, 209–221.

Martini, A., Neirotti, P., and Appio, F.P. (2017) Knowledge searching, integrating, and performing: always a tuned trio for innovation? *Long Range Planning*, **50**, 2, 200–220.

Masroor, N. and Asim, M. (2019) SMEs in the contemporary era of global competition. *Procedia Computer Science*, **158**, 632–641.

McCann, P. and Ortega-Argilés, R. (2016) Smart specialization, entrepreneurship, and SMEs: issues and challenges for a results-oriented EU regional policy. *Small Business Economics*, **46**, 4, 537–552.

Medda, G. (2020) External R&D, product, and process innovation in European manufacturing companies. *The Journal of Technology Transfer*, **45**, 1, 339–369.

Mellahi, K. and Eyuboglu, F. (2001) Critical factors for successful total quality management implementation in Turkey: Evidence from the banking sector. *Total Quality Management*, **12**, 6, 745–756. https://doi.org/10.1080/09544120120075352.

Mensah, J.O., Copuroglu, G., and Fening, F.A. (2012) Total quality management in Ghana: critical success factors and model for implementation of a quality revolution. *Journal of African Business*, **13**, 2, 123–133. https://doi.org/10.1080/15228916.2012.693444.

Montresor, S. and Vezzani, A. (2015) The production function of top R&D investors: accounting for size and sector heterogeneity with quantile estimations. *Research Policy*, **44**, 2, 381–393.

Morgan, N.A., Katsikeas, C.S., and Vorhies, D.W. (2012) Export marketing strategy implementation, export marketing capabilities, and export venture performance. *Journal of the Academy of Marketing Science*, **40**, 2, 271–289.

Motta, V. (2020) Lack of access to external finance and SME labor productivity: does project quality matter? *Small Business Economics*, **54**, 1, 119–134.

NBSSI (2020) *National Board for small scale industries*. Accra, Ghana: National Board of Smale Scale Industries.

Neter, J., Kutner, M.H., Nachtsheim, C.J., and Wasserman, W. (1996) Applied linear statistical models.

Nonaka, I. and Takeuchi, H. (1995) *The knowledge-creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nunnally, J. and Bernstein, I. (1994) *Psychometric theory*, 3rd edn. New York: MacGraw Hill.

Oduro, S. (2019) Examining open innovation practices in low-tech SMEs: insights from an emerging market. *Journal of Science and Technology Policy Management*, **10**, 3, 509–532.

Padgett, R.C. and Galan, J.I. (2010) The effect of R&D intensity on corporate social responsibility. *Journal of Business Ethics*, **93**, 3, 407–418.

Parida, V. and Örtqvist, D. (2015) Interactive effects of network capability, ICT capability, and financial slack on technology-based small firm innovation performance. *Journal of Small Business Management*, **53**, 278–298.

Perdomo-Ortiz, J., Gonzalez-Benito, J., and Galende, J. (2009) An analysis of the relationship between total quality management-based human resource management practices and innovation. *The International Journal of Human Resource Management*, **20**, 5, 1191–1218.

Pereira-Moliner, J., Claver-Cortés, E., Molina-Azorín, J.F., and Tarí, J.J. (2012) Quality management, environmental management, and firm performance: direct and mediating effects in the hotel industry. *Journal of Cleaner Production*, **37**, 82–92.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. (2003) Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, **88**, 5, 879–903.

Podsakoff, P.M., MacKenzie, S.B., and Podsakoff, N.P. (2012) Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, **63**, 539–569.

Podsakoff, P.M. and Organ, D.W. (1986) Self-reports in organizational research: problems and prospects. *Journal of Management*, **12**, 4, 531–544.

Prajogo, D.I. and Sohal, A.S. (2003) The relationship between TQM practices, quality performance, and innovation performance. *International Journal of Quality & Reliability Management*, **20**, 901–918.

Prajogo, D.I. and Sohal, A.S. (2006) The integration of TQM and technology/R&D management in determining quality and innovation performance. *Omega*, **34**, 3, 296–312.

Preacher, K.J., Rucker, D.D., and Hayes, A.F. (2007) Addressing moderated mediation hypotheses: theory, methods, and prescriptions. *Multivariate Behavioral Research*, **42**, 1, 185–227.

Raymond, L. and St-Pierre, J. (2010) R&D as a determinant of innovation in manufacturing SMEs: an attempt at empirical clarification. *Technovation*, **30**, 1, 48–56.

Ruiqi, W., Wang, F., Xu, L., and Yuan, C. (2017) R&D expenditures, ultimate ownership, and future performance: evidence from China. *Journal of Business Research*, **71**, 47–54.

Salunke, S., Weerawardena, J., and McColl-Kennedy, J.R. (2019) The central role of knowledge integration capability in service innovation-based competitive strategy. *Industrial Marketing Management*, **76**, 144–156.

Satta, G., Parola, F., Penco, L., and Esposito de Falco, S. (2016) Insights to technological alliances and financial resources as antecedents of high-tech firms' innovative performance. *R&D Management*, **46**, 1, 127–144.

Senaratne, C., Wang, C.L., and Sarma, M. (2022) Commonalities and specificities of dynamic capabilities: a mixed methods study of UK high-tech SMEs. *R&D Management*, **52**, 735–754. https://doi.org/10.1111/radm.12518.

Shaikh, I.A., O'Brien, J.P., and Peters, L. (2018) Inside directors and the underinvestment of financial slack towards R&D-intensity in high-technology firms. *Journal of Business Research*, **82**, 192–201.

Singh, R., Chandrashekar, D., Hillemane, B.S.M., Sukumar, A., and Jafari-Sadeghi, V. (2022) Network cooperation and economic performance of SMEs: direct and mediating impacts of innovation and internationalisation. *Journal of Business Research*, **148**, 116–130.

Slater, S.F. and Narver, J.C. (1998) Customer-led and market-oriented: let's not confuse the two. *Strategic Management Journal*, **19**, 10, 1001–1006. https://doi.org/10.1002/(sici)1097-0266(199810)19:10<1001::aid-smj996>3.0.co;2-4.

Sung, S.Y. and Choi, J.N. (2018) Building knowledge stock and facilitating knowledge flow through human resource management practices toward firm innovation. *Human Resource Management*, **57**, 6, 1429–1442.

Teirlinck, P. (2017) Configurations of strategic R&D decisions and financial performance in small-sized and medium-sized firms. *Journal of Business Research*, **74**, 55–65.

Terziovski, M. and Guerrero, J.-L. (2014) ISO 9000 quality system certification and its impact on product and process innovation performance. *International Journal of Production Economics*, **158**, 197–207. https://doi.org/10.1016/j.ijpe.2014.08.011

ThaiHoang, D., Igel, B., and Laosirihongthong, T. (2006) The impact of total quality management on innovation. *International Journal of Quality & Reliability Management*, **23**, 9, 1092–1117. https://doi.org/10.1108/02656710610704230.

Tran, K.T., Nguyen, P.V., and Nguyen, L.M. (2018) The role of financial slack, employee creative self-efficacy and learning orientation in innovation and organizational performance. *Administrative Sciences*, **8**, 4, 82.

Wang, C.L. and Rafiq, M. (2014) Ambidextrous organizational culture, contextual ambidexterity, and new product innovation: a comparative study of UK and Chinese high-tech firms. *British Journal of Management*, **25**, 1, 58–76.

World Economic Forum (2022) Future Readiness of SMEs and Mid-Sized Companies: A Year On, Insight Report, November 2022. Retrieved from https://www3.weforum.org/docs/WEF_Future_Readiness_of_SMEs_and_Mid_Sized_Companies_A_Year_On_2022.pdfUSA.

WorldBank (2018) *The little data book on Africa 2011*. Washington, DC: World Bank.

Wu, J. and Shanley, M.T. (2009) Knowledge stock, exploration, and innovation: research on the United States

electromedical device industry. *Journal of Business Research*, **62**, 4, 474–483.

Wu, W.Y., Tsai, H.J., Cheng, K.Y., and Lai, M. (2006) Assessment of intellectual capital management in Taiwanese IC design companies: using DEA and the Malmquist productivity index. *R&D Management*, **36**, 5, 531–545.

Zahra, S.A. and George, G. (2002) The net-enabled business innovation cycle and the evolution of dynamic capabilities. *Information Systems Research*, **13**, 2, 147–150.

Zeng, J., Phan, C.A., and Matsui, Y. (2015) The impact of hard and soft quality management on quality and innovation performance: an empirical study. *International Journal of Production Economics*, **162**, 216–226.

Zhao, X. and Tan, J. (2021) The performance implications of patenting–the moderating effect of informal institutions in emerging economies. *R&D Management*, **51**, 5, 468–483.

Zhou, K.Z. and Li, C.B. (2012) How knowledge affects radical innovation: knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal*, **33**, 9, 1090–1102.

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