Co-creation as a means to innovate: The role of vertical strategic collaborations and R&D teams for enhanced innovation among Latin American SMEs

Co-creación como medio para innovar: El papel de las colaboraciones estratégicas verticales y los equipos de I+D para mejorar la innovación en pymes latinoamericanas

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Abstract: Innovation in small and medium-sized enterprises (SMEs) increasingly depends on collaborative approaches that integrate internal capabilities with external knowledge sources. In emerging economies, resource constraints and uneven digitalization often push firms to leverage vertical strategic collaborations and internal research and development (R&D) teams as mechanisms for enhancing product innovation. This study examines whether and how vertical collaborations with suppliers and customers, as well as the presence of an internal R&D team, influence product innovation outcomes in Latin American SMEs. Using survey data from 477 SMEs in five countries and applying multilevel logit regression, the results show that supplier collaborations are positively and significantly associated with product innovation, while customer collaborations are not statistically significant. The presence of an R&D team has a strong positive effect but negatively moderates the relationship between supplier collaboration and product innovation, indicating a substitution effect. These findings highlight the importance of supplier partnerships for SMEs lacking internal R&D capabilities and the strategic role of R&D teams in shaping collaboration outcomes. The study offers theoretical and practical insights for managers and policymakers seeking to enhance innovation capacity in resource-constrained contexts.

Keywords: Strategic collaborations, R&D teams, product innovation, multilevel analysis, Latin America.

Resumen: La innovación en las pequeñas y medianas empresas (pymes) depende cada vez más de enfoques colaborativos que integren las capacidades internas con las fuentes de conocimiento externas. En las economías emergentes, las limitaciones de recursos y la digitalización desigual crean tanto la necesidad como la oportunidad de aprovechar las colaboraciones estratégicas verticales y los equipos internos de investigación y desarrollo (I+D) como mecanismos para mejorar la innovación de productos. Este estudio examina si las colaboraciones verticales con proveedores y clientes, así como la presencia de un equipo interno de I+D, influyen en los resultados de la innovación de productos en las pymes latinoamericanas y de qué manera lo hacen. Utilizando datos de 477 pymes en cinco países y aplicando una regresión logística multinivel, los resultados muestran que las colaboraciones con proveedores son positivas y se asocian significativamente con la innovación de producto, mientras que, las colaboraciones con los clientes no son estadísticamente significativas. La presencia de un equipo de I+D tiene un fuerte efecto positivo, pero modera negativamente la relación entre la colaboración con proveedores y la innovación de productos, lo que indica un efecto de sustitución. Estos hallazgos resaltan la importancia de las asociaciones con proveedores para pymes que no cuentan con capacidades internas de I+D, así como el rol estratégico de los equipos de I+D en la configuración de los resultados de la colaboración. El estudio ofrece conocimientos teóricos y prácticos para gerentes y responsables políticos que buscan mejorar la capacidad de innovación en contextos con recursos limitados.

Palabras clave: Colaboraciones estratégicas, equipos de I+D, innovación de producto, análisis multinivel, Latinoamérica.

1. Introduction

Innovation is a critical driver of competitiveness and innovation for small and medium-sized enterprises (SMEs), enabling them to respond to changing market conditions, enhance productivity, and sustain long-term growth and performance (e.g., Lafuente et al., 2020; Lafuente et al., 2023; Vendrell-Herrero et al., 2021). Organizations follow different pathways to engage in innovation processes. In recent years, collaborative approaches such as co-creation—where firms jointly develop products, services, or processes with other stakeholders—have become central to innovation strategies (González-Benito et al., 2016; Fliaster & Kolloch, 2017; Markovic & Bagherzadeh, 2018; Van den Broeke & Paparoidamis, 2021). These strategies allow SMEs to overcome resource constraints by integrating internal capabilities with external knowledge and resources.

As in other geographies, Latin American SMEs face a number of challenges that make collaboration particularly relevant. Structural limitations such as restricted access to finance, underdeveloped technological infrastructure, and uneven digitalization can hamper firms' innovation potential (Ács et al., 2022; Lafuente et al., 2022; Rojas-Segura et al., 2023). At the same time, dynamic market environments and the need for competitive differentiation push SMEs to seek partnerships that improve their innovation capacity. In this context, two mechanisms are especially relevant: strategic collaborations and internal research and development (R&D) teams.

Strategic collaborations—defined as structured cooperative agreements between the firm and other actors in its value chain aimed at developing new products or improving existing ones (Markovic & Bagherzadeh, 2018; Lafuente & Vaillant, 2023, Vaillant & Lafuente, 2024)—promote knowledge and information exchange between parties as they work together to achieve a common goal while reducing development costs, promoting access to extensive networks, and increasing the potential value resulting from the innovation-led co-creation process (González-Benito et al., 2016; Vendrell-Herrero et al., 2023). In this sense, different actors connected to the firm, such as suppliers, customers, and strategic industry partners, play a decisive role (Lafuente et al., 2010; Hidalgo & Herrera, 2020; Lafuente et al., 2023; Ramaswamy & Ozcan, 2014).

R&D teams—internal units dedicated to generating and applying knowledge for product or process innovation (Adomako et al., 2021)—constitute another important mechanism that has the potential to increase the firm's knowledge stock and technical capabilities, which, in turn, might influence firms' innovation outcomes directly or more indirectly (Vendrell-Herrero et al., 2021).

Despite the growing importance of these two mechanisms, there is limited empirical research on how they interact to shape innovation outcomes in SMEs, particularly in emerging contexts. Understanding how these two innovation strategies interact is critical for designing effective policies and managerial practices. Therefore, this study attempts to answer the following research questions: Do vertical strategic collaborations with suppliers and customers, as well as R&D teams, impact firms' product innovation? Moreover, does the presence of an R&D team moderate the effect of strategic collaborations on product innovation?

Based on these arguments, this research analyzes the influence of vertical strategic collaborations on product innovation in five Latin American countries. The study also seeks to identify the influence of R&D teams on product innovation while acknowledging the potential moderating effect of such teams on the relationship between strategic collaborations and innovation.

To test the proposed hypotheses empirically, the study uses multilevel regression analysis on a sample drawn from an international project on SMEs' digitalization, including data for 477 SMEs from five Latin American countries for 2021 (Argentina, Costa Rica, Ecuador, Mexico, and Uruguay). Additionally, comparisons between innovative firms with and without an R&D team are performed to further verify the joint effect of strategic collaborations and R&D teams on product innovation.

The study's core findings confirm the relevance of strategic collaborations with suppliers for SMEs' innovation by showing that, when engaging in innovation processes, SMEs rely on vertical strategic collaborations to compensate for the absence of an internal R&D team. For entrepreneurs and strategy makers, the results of this research can offer a guide to implement strategic actions and collaboration alliances in order to improve SMEs' innovative performance.

In line with recent calls for more research on collaborative networks, co-creation, and product innovation (González-Benito et al., 2016; Bettiga & Ciccullo, 2019; Lafuente & Vaillant, 2023; Zhang et al., 2023; Vaillant & Lafuente, 2024), this study offers three main contributions. First, it contributes to advance theory by examining the interaction between internal and external innovation mechanisms, revealing potential substitution effects with relevant implications for the strategic design of innovation processes (Vendrell-Herrero et al., 2021). Second, it contributes to firms' strategy making by offering guidance on how SMEs can strategically allocate resources between internal R&D capabilities and external partnerships to maximize innovation outcomes (Ács et al., 2022; Lafuente et al., 2024). Third, this research contributes to understanding how strategic collaborations with suppliers and customers impact product innovation results. It also considers the complexity of the innovation process and addresses the adoption of a cross-level approach by using a multiple-level analysis (Bogers et al., 2017).

The study plan is as follows. Section 2 presents the theoretical framework supporting the proposed hypotheses, whereas Section 3 describes the data and methodology. Section 4 presents the main results. Section 5 offers the discussion, and Section 6 presents the concluding remarks, implications, and future research lines.

2. Background Theory

2.1 Strategic Collaborations and Product Innovation

From a strategic perspective, developing collaborations with different external stakeholders (e.g., suppliers, customers, competitors, universities, and research centers) contributes to overcome firms' resource limitations, while equipping organizations with a wide range of external resources—including tangible and knowledge-based resources—that have the potential to improve firms' innovation performance (Chesbrough, 2003; Ramaswamy & Ozcan, 2014; Kazadi et al., 2016; Lafuente et al., 2023; Lafuente & Sallan, 2024; Vendrell-Herrero et al., 2021).

There are different ways in which companies collaborate with stakeholders. In the specific context of this research, vertical strategic collaborations refer to structured, long-term cooperative arrangements between the firm and other actors involved in its value chain—typically suppliers and customers—aimed at jointly developing new products or improving existing ones (Markovic & Bagherzadeh, 2018; Lafuente & Vaillant, 2023). These collaborations promote mutual knowledge exchange, resource sharing, and joint problem-solving, thus potentially enhancing the firm's innovation capacity. Product innovation, in turn, is understood in this study as the introduction of new products or significant modifications to existing products to meet evolving market demands (Chesbrough, 2010). Through strategic collaboration practices designed for co-innovation, firms cannot only improve their innovation processes but also contribute to augmenting firms' knowledge stock as well as networks by being part of a collaborative innovation system that transcends resource endowments and develops collaborations through synergic complementarity (Zott & Amit, 2010). This view supports the notion that innovation capabilities are synergistically generated through collaborative activities, which, in turn, increases firms' innovation potential in comparison to their own resource endowments (Lafuente et al., 2023).

Suppliers are key actors of collaborative innovation systems. Suppliers provide critical inputs, technologies, and expertise that influence a firm's ability to develop new products and processes. Supplier collaboration enhances innovation by enabling knowledge-sharing, reducing product development time, and improving the quality of innovation outputs. Moreover, strong supplier relationships facilitate joint problem-solving, risk-sharing, and the development of customized solutions, which are crucial for innovation success (Petersen et al., 2005; Markovic & Bagherzadeh, 2018; Van den Broeke & Paparoidamis, 2021). For example, when firms co-innovate with suppliers, they can integrate suppliers' expertise into the design phase, leading to more effective solutions and cost efficiencies (Wagner & Bode, 2014; Lafuente et al., 2023).

Customers are also relevant stakeholders who can provide valuable insights that drive demand-driven innovation. By directly engaging customers in innovation processes, firms can better understand customer needs, preferences, and emerging trends, enabling them to develop more relevant and successful innovations (Von Hippel, 2005; Lafuente & Vaillant, 2023). Lead users, in particular, are a crucial source of innovation, as they experience market needs earlier than the business and can contribute unique insights that firms might overlook. Strategic collaboration with customers also enhances service and product customization, leading to higher adoption rates and market success (Frow et al., 2015).

Furthermore, digital transformation and technological advancements have facilitated more effective customer engagement through platforms and social media, equipping firms with the technology to obtain real-time feedback and collaborative opportunities (Nambisan, 2017; Usai et al., 2021; Lafuente & Sallan, 2024). Firms that integrate customers' input into their innovation processes tend to develop more user-centered innovations, thereby increasing customer satisfaction and loyalty long-term (Sjödin et al., 2020; Lafuente et al., 2023).

Strategic collaborations with suppliers and customers can significantly improve firms' innovation capacity by leveraging external resources, knowledge, and expertise (González-Benito et al., 2016; Lafuente & Vaillant, 2023). Suppliers contribute critical input, technologies, and market knowledge (Petersen et al., 2005), while customers, in particular lead users, provide insights into unmet needs and emerging trends (Von Hippel, 2005). However, vertical collaborations are not essential conditions for innovation, as firms might achieve product innovation through other mechanisms, such as strategic alliances with industry partners or universities or serendipitous market discoveries (Laursen & Salter, 2006). Moreover, collaboration outcomes might depend on partner properties, partners' absorptive capacity, and alignment of objectives (Sjödin et al., 2020). Empirical evidence suggests that firms that actively engage with stakeholders in structured co-innovation networks are more likely to achieve superior innovation results and value creation, ultimately securing the firm's competitive position (Ramaswamy & Ozcan, 2014; González-Benito et al., 2016; Fliaster & Kolloch, 2017; Markovic & Bagherzadeh, 2018; Lafuente et al., 2020; Lafuente & Vaillant, 2023). Based on this theory and evidence, the following hypothesis is proposed:

H1: Firms engaging in (vertical) strategic collaborations with suppliers and customers are more likely to develop product innovation.

2.2 R&D Teams and Product Innovation

Businesses might dedicate internal resources and capabilities to develop innovations through an internal research and development (R&D) team. R&D teams—defined as internal units focused on generating new knowledge and translating it into innovative products or processes (Zahra & George, 2002; Adomako et al., 2021)—are the backbone of firms' innovation engine, playing a crucial role in generating new knowledge and transforming ideas into marketable products and services (Vendrell-Herrero et al., 2021).

R&D teams improve firms' absorptive capacity, enabling them to integrate external knowledge effectively and anticipate technological changes (Teece, 2018). R&D teams can directly drive innovation performance by engaging in problem-solving, experimentation, and iterative development, which are essential for maintaining a firm's competitive advantage in fast-evolving industries (Usai et al., 2021). The underlying mechanism explaining the role of R&D teams for developing new products or improving existing ones lies in one of the core strengths of R&D teams, namely, their absorptive capacity—the ability to recognize, assimilate, and apply external knowledge to internal innovation processes (Zahra & George, 2002).

High absorptive capacity allows R&D teams to leverage in-house expertise, external knowledge, scientific discoveries, and market feedback. Additionally, firms with strong, active R&D teams can anticipate technological disruptions and proactively invest in emerging technologies before competitors, ensuring long-term sustainability (Teece, 2018; Lafuente et al., 2018).

While R&D teams are instrumental in internal innovation processes, their effectiveness might be significantly amplified when complemented by strategic collaborations with stakeholders (in the case of this research, suppliers, and customers). These external agents enhance the scope and depth of innovation by integrating diverse perspectives, expertise, and resources that R&D teams alone may lack (Vendrell-Herrero et al., 2021).

Specifically, close integration between R&D teams and suppliers might facilitate knowledge transfer, allowing firms to reduce product development cycles and improve design efficiency and commercialization periods. Additionally, strategic collaborations with suppliers ensure that R&D teams receive critical input on technical feasibility, reducing costly redesigns and increasing innovation success rates (Usai et al., 2021).

Customers, particularly lead users, provide insights into unmet needs and future market trends, helping R&D teams align innovation efforts with real-world demands. Co-innovation initiatives, where R&D teams engage directly with customers in idea generation and prototyping, lead to more user-centric innovations and improved adoption rates (Vendrell-Herrero et al., 2021).

Vertical strategic collaborations that result from the interplay between internal R&D teams and external stakeholders (i.e., suppliers and customers) create a synergistic innovation ecosystem (Lafuente et al., 2023). While R&D teams provide the technical expertise and problem-solving capabilities, suppliers and customers contribute contextual knowledge, reducing the risks associated with new product development (Laursen & Salter, 2006). Firms that effectively integrate internal R&D efforts with external collaborative networks tend to achieve superior innovation performance, greater market acceptance, and sustained competitive advantage (Adomako et al., 2021; Usai et al., 2021; Vendrell-Herrero et al., 2021).

Although the presence of an R&D team is not an indispensable condition for innovation because SMEs might innovate through external partnerships, contract research, or participation in industry consortia (Bettiga & Ciccullo, 2019; Vendrell-Herrero et al., 2023), existing work indicates that R&D teams are critical drivers of innovation, and their impact is amplified when combined with strategic co-innovation collaborations. This integration fosters knowledge-sharing, reduces development risks, and enhances both the efficiency and market relevance of innovation efforts to create new products or improve existing ones.

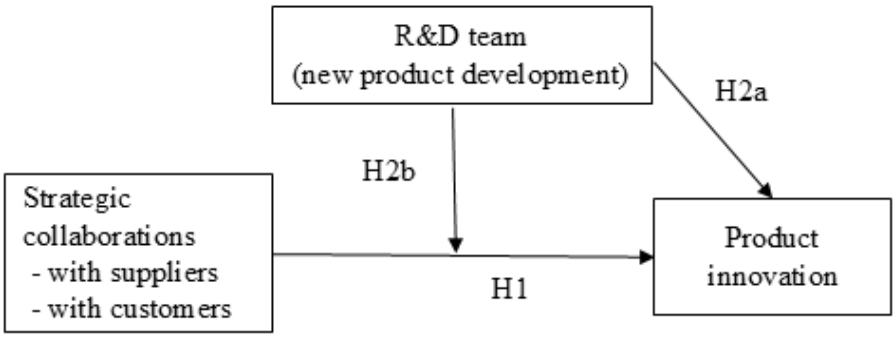
While prior research has explored the independent effects of vertical collaborations and R&D teams on innovation, few studies have examined their interaction, especially in emerging economies. Understanding this dynamic is critical in contexts like Latin America, where firms often operate under resource scarcity and varying levels of digital maturity. Therefore, the following hypotheses are proposed:

H2a: Firms with an internal R&D team are more likely to develop product innovation.

H2b: The presence of an internal R&D team positively moderates the relationship between strategic collaborations (with suppliers and customers) and product innovation.

Figure 1 presents the research model proposed in this study to evaluate the influence of vertical strategic collaborations and R&D teams on SMEs' product innovation.

Figure 1: Research model



Overall, from the theory and evidence presented in Section 2 it can be deduced that, despite the extensive literature on innovation and R&D management (e.g., González-Benito et al., 2016; Bettiga & Ciccullo, 2019; Lafuente & Vaillant, 2023; Zhang et al., 2023), gaps remain in understanding how internal and external mechanisms interact to shape product innovation in SMEs, particularly in resource-constrained and digitally uneven environments such as Latin America (Ács et al., 2022; Lafuente et al., 2024). Most prior work focuses on the role of either strategic collaborations or R&D teams in isolation, ignoring their potential complementary or substitution effects. This study addresses this gap by jointly analyzing vertical strategic collaborations and R&D teams, assessing their independent and joint effects on product innovation across five Latin American countries, seeking to increase and update the theoretical discussion on this relevant topic for organizations (Vendrell-Herrero et al., 2021, Bonaque-Rodríguez et al., 2024; Ozturk et al., 2024; Lafuente et al., 2024).

3. Data, Variable Selection and Method

3.1 Data

The data used to test the proposed hypotheses was drawn from an international research project on SMEs' digitalization in Latin America funded by the Konrad Adenauer Foundation (Konrad Adenauer Stiftung, KAS) (Bartesaghi & Weck, 2022) and developed by a team of universities from five countries: Argentina (Universidad Católica de Córdoba), Costa Rica (Costa Rica Institute of Technology), Ecuador (Universidad Católica de Guayaquil), Mexico (Tecnológico de Monterrey), and Uruguay (Universidad Católica de Uruguay). The project was coordinated by researchers from the Universidad Católica de Uruguay.

The data was collected for the purpose of this study, and researchers from the participating universities supervised the data collection process. The data was collected between February and June 2021 through an online structured questionnaire using the Qualtrics platform. The unit of analysis is the firm, and the instrument was answered by owners and managers familiar with the firm's strategy as well as its operations and digitalization approach.

The final sample includes information for 477 SMEs. Geographic diversity and differences in economic activity corroborate the validity of the final sample. For example, the firms included in the final sample are evenly distributed across the participating countries: Argentina = 90 cases, Costa Rica = 93 cases, Ecuador = 106 cases, Mexico = 82 cases, and Uruguay = 106 cases.

Also, the breakdown of firms by industry presented in Table 1 shows the diversity in the economic activity of the sampled firms: manufacturing (15.09%), retail (24.95%), technology-based sectors (12.16%), consumer-oriented services (35.22%), and others (healthcare services, financial services, and other consumer services) (12.58%).

3.2 Variable Selection

Product innovation—Similar to prior work, the dependent variable used in this study focuses on firms' product innovation (i.e., new product development and significant amendments to products) (Chesbrough, 2010; Frow et al., 2015; Lafuente et al., 2019). In line with prior work (e.g., Chesbrough, 2010; Lafuente et al., 2023), specific questions were included in the survey instrument to identify those firms engaging in strategies to develop new products or significantly improve existing ones. Respondents' answers were coded in a single dummy variable that aims to capture product innovation outcomes. The descriptive statistics presented in Table 1 show that 47% of the sampled firms are involved in the analyzed product innovation processes and that this rate varies across the studied countries (Argentina: 31%, Costa Rica: 56%, Ecuador: 51%, Mexico: 48%, and Uruguay: 48%).

Table 1: Descriptive statistics for the selected variables

	Argentina	Costa Rica	Ecuador	Mexico	Uruguay	Total
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Panel A: Innovation						
New product development	0.3111 (0.4655)	0.5591 (0.4992)	0.5094 (0.5023)	0.4756 (0.5025)	0.4811 (0.5020)	0.4696 (0.4996)
Panel B: Vertical strategic collaborations						
Suppliers	0.3222 (0.4699)	0.2688 (0.4457)	0.4717 (0.5016)	0.4024 (0.4934)	0.1509 (0.3597)	0.3208 (0.4673)
Customers	0.2667 (0.4447)	0.1935 (0.3972)	0.3962 (0.4914)	0.2073 (0.4079)	0.1792 (0.3854)	0.2516 (0.4344)
Panel C: R&D teams						
Internal R&D team	0.3222 (0.4699)	0.4839 (0.5024)	0.5755 (0.4966)	0.3780 (0.4879)	0.3113 (0.4652)	0.4172 (0.4936)
Panel D: Controls						
Size (employees)	55.2333 (93.8894)	20.2581 (25.0742)	28.0755 (57.5738)	45.2317 (85.6271)	18.8208 (40.9194)	32.5681 (65.7184)
Age (years)	25.4889 (21.4215)	19.2903 (17.0061)	14.5943 (11.7488)	16.3902 (14.7119)	18.6226 (17.9748)	18.7694 (17.1376)
Manufacturing	0.2111 (0.4104)	0.0645 (0.2470)	0.2358 (0.4265)	0.1220 (0.3292)	0.1132 (0.3184)	0.1509 (0.3584)
Retail	0.1778 (0.3845)	0.1935 (0.3972)	0.3302 (0.4725)	0.2561 (0.4392)	0.2736 (0.4479)	0.2495 (0.4332)
Technology-based industries	0.1556 (0.3645)	0.1613 (0.3698)	0.0943 (0.2937)	0.1098 (0.3145)	0.0943 (0.2937)	0.1216 (0.3272)
Consumer services	0.2556 (0.4386)	0.3333 (0.4740)	0.3396 (0.4758)	0.2805 (0.4520)	0.5189 (0.5020)	0.3522 (0.4782)
Others (healthcare services, financial services, and other consumer services)	0.2000 (0.4022)	0.2473 (0.4338)	0.0000 (0.0000)	0.2317 (0.4245)	0.0000 (0.0000)	0.1258 (0.3320)
Number of cases	90	93	106	82	106	477

Standard deviation is presented in brackets.

Strategic collaborations—This study evaluates two types of vertical strategic collaborations, namely, collaboration with suppliers (González-Benito et al., 2016) and customers (Wu et al., 2023). Following the data collection process, managers were specifically asked to indicate if the firm has implemented joint development programs during the last year with suppliers and customers. Similar to previous studies (e.g., Markovic & Bagherzadeh, 2018; Lafuente & Vaillant, 2023), two dummy variables were created to identify firms' vertical collaborations with suppliers and customers, and descriptive statistics in Table 1 show that 32% and 25% of firms collaborate with suppliers and customers, respectively. In addition, Ecuadorian firms report the highest proportion of firms engaged in strategic collaborations (suppliers: 47%, customers: 40%), whereas the lowest rate of vertical collaborations was found among Uruguayan firms (suppliers: 15%, customers: 18%).

R&D team—The presence of a permanent R&D team in the firm was also used as an independent and moderating variable in the research model (Vendrell-Herrero *et al.*, 2021). Following previous studies (Adomako et al., 2021; Usai et al., 2021), this dummy variable takes the value of one if respondents indicated that the firm has an interdisciplinary R&D team focused on new product development, and zero otherwise. Descriptive statistics in Table 1 indicate that 42% of the sampled firms have an internal R&D team, ranging between 31% (Uruguayan firms) and 58% (Ecuadorian firms).

Control variables—All model specifications control for size, age, and industry. Firm size is measured by the number of employees, while firm age is expressed as the number of years of market experience. Notice that both firm size and firm age were logged to reduce skewness. Finally, a set of industry-specific dummy variables was included in all models to rule out potential effects linked to the SMEs' economic activity (the reference category includes industries related to healthcare services, financial services, and other consumer services). The set of control variables follow standard practice in innovation studies (e.g., Lederman, 2010; González-Benito et al., 2016; Lafuente et al., 2019).

3.3 Method

In this study, we argue that engaging in strategic collaborations with suppliers and customers and having an internal R&D team increase firms' product innovation outcomes, whereas R&D teams positively moderate the relationship between strategic collaborations (with suppliers and customers) and product innovation. Given the properties of the dependent variable and the nested nature of the firm—with firms (*i*) grouped within countries (*c*)—a multilevel binary logistic regression was applied to account for potential between-country variation in innovation outcomes. This approach is preferred over standard binary choice models as ignoring the hierarchical structure of the data might lead to compute inconsistent coefficients and biased standard errors (Snijders & Bosker, 2012).

To test the proposed hypotheses, we therefore used a multilevel logit model, in which level-one data (*i*= firm) are nested in one category: level-two (*c*= country). The full model estimated in this study has the following form:

$$\begin{aligned}\text{Product innovation}_{ic} &= \beta_{00} + \beta_{0c} + \beta_1 \text{Strategic collaborations}_{ic} + \beta_2 \text{R\&D}_{ic} \\ &+ \beta_{12} \text{Strategic collaborations}_{ic} \times \text{R\&D}_{ic} + \beta_3 \text{Control variables}_{ic} + \varepsilon_{ic}\end{aligned} \quad (1)$$

In equation (1), *i* indexes firms and *c* countries, β_{oo} is the overall mean of the dependent variable (i.e., product innovation) and β_{oc} is the randomly distributed country effect, that is, the variance of the mean value of product innovation for each country (*c*) around the overall average product innovation. The firm-level variables include 'strategic collaborations' (with suppliers and customers), R&D team, and the set of control variables: size (ln number of employees), firm age (ln years of market experience), and industry.

For enhanced robustness of the proposed analysis, the country effect was tested. The between-country variance of the overall innovation was estimated to determine the appropriateness of the proposed multilevel model (equation (1)). The results of the intercept-only model (Model 1 in Table 2), which shows the proportion of the total variance in the dependent variable between countries, were used to estimate the inter-class correlation coefficient (ICC). The results in Model 1 indicate that the mean product innovation among countries is 0.0212 (without controlling for firm-level covariates). For the full model (specification 2), the ICC value is 0.0254, suggesting that 2.54% of variations in firms' product innovation (i) lie between the studied countries (c). Although the result of the ICC lies in the low-level acceptance area according to the rule of thumb proposed by Hox (2010), the reported between-country variation and the nature of the empirical exercise—which is based on the international comparison of SMEs' innovation outcomes—justify the proposed multilevel approach.

As for the study's hypotheses, we expect $\beta_1 > 0$ to confirm that firms engaging in vertical strategic collaborations with suppliers and customers are more likely to develop product innovation (H1). A positive and significant coefficient for the R&D team variable $\beta_2 > 0$ would corroborate that firms with an internal R&D team are more likely to develop product innovation (H2a). Finally, a positive and significant result for the parameter linked to the interaction term between strategic collaborations and R&D teams $\beta_{12} > 0$ would indicate that an internal R&D team positively moderates the relationship between strategic collaborations (with suppliers and customers) and product innovation (H2b).

4. Results

This section deals with the study's empirical findings. Section 4.1 offers the results (coefficients and marginal effects) of the multilevel logit model of product innovation (Table 2), while the robustness checks are presented in Section 4.2 (Table 3).

4.1 Product Innovation: Multilevel Analysis

Table 2 reports the estimates of the multilevel model used to test the study's hypotheses. To aid the interpretation of the findings, the table also includes the marginal effects. Notice that a likelihood ratio test comparing the multi-level results and estimations computed via a standard logit model was performed to further validate the robustness of the study's empirical approach. The results of this diagnostic test (LR test, multilevel vs. logit model= 3.02 and p-value < 5%) indicate that the multi-level model offers more accurate estimations of the effect of strategic collaborations and R&D teams on product innovation viz.-à-viz. results generated via logit regression.

Also, the variance inflation factor (VIF) was computed for the full model to test whether coefficients are amplified due to correlations across the explanatory variables. The average VIF value for the full model in column 2 of Table 2 is 2.12 (range = 1.27-3.05). The highest VIF values were observed for the interaction term between the presence of an internal R&D team and the variables linked to the strategic collaborations with customers (3.05) and suppliers (2.86). Overall, these results suggest that the model specification does not suffer from collinearity problems, thereby further validating our empirical approach (Greene, 2003).

The results suggest that vertical strategic collaborations with suppliers are positively correlated with SMEs' product innovation ($\beta_1 > 1.0804$ and p-value<0.000). However, the result is not significant when vertical strategic collaborations with customers are analyzed (Table 2) ($\beta_1 > 0.0726$, p-value=0.15). In terms of interpretation, the result of the marginal effect for the variable linked to strategic collaborations with suppliers indicate that the probability to develop product innovations increases 23.22 percentage points among firms that engage in such collaborations, compared to the probability of firms that do not collaborate with suppliers.

These findings offer partial support to the study's first hypothesis (H1), stating that firms developing vertical strategic collaborations with suppliers and customers are more likely to develop product innovation.

The complexity of innovation processes might amplify among SMEs because they are often subject to liabilities of smallness (Runst & Thomä, 2022), which not only hinder product-development processes but also puts to the test SMEs' capacity to match new knowledge brought from outside with their internal operations (Voss & Voss, 2013). While a strong connection with suppliers is essential for any business, the organizational consequences of such liabilities of smallness—which can materialize in the lack of resources to actively interact with customers—might explain the weak effect of collaborations with customers on SME's product innovation.

Table 2: Multilevel analysis of new product innovation

	Model 1 (null)	Model 2 (full)	
	Coefficients	Coefficients	Average marginal effects
Intercept	–0.1306 (0.1512)	–0.6693 (0.4920)	
Vertical strategic collaborations (suppliers)		1.0804 (0.3055)***	0.2322 (0.0617)***
Vertical strategic collaborations (customers)		0.0726 (0.3426)	0.0156 (0.0736)
R&D teams		1.3544 (0.2683)***	0.2912 (0.0515)***
R&D teams x Vertical strategic collaborations (suppliers)		–0.7788 (0.4588)*	–0.1674 (0.0972)*
R&D teams x Vertical strategic collaborations (customers)		0.1149 (0.4933)	0.0247 (0.1060)
Size (ln labor)		–0.1714 (0.1056)	–0.0368 (0.0226)
Age (ln business age)		0.0268 (0.1434)	0.0058 (0.0308)
Industry dummies		Yes	
Variance (country)	0.0711 (0.0748)	0.0858 (0.0907)	
Log likelihood	–328.2089	–299.1965	
Wald test (chi2)		51.55***	
Pseudo R2		0.0884	
ICC	0.0212	0.0254	
LR test (null vs. full)		58.02***	
LR test (multilevel vs. logit model)		3.02**	
Observations (Countries)	477 (5)	477 (5)	

*Standard errors are presented in brackets. *, **, *** = Significant at the 10%, 5%, and 1%, respectively.*

The variable related to R&D teams was found to be positively associated with new product developments (Table 2: (β_2>1.3544 and p-value<0.000)). For this variable, the result of the marginal effect indicates that for firms with an internal R&D team the probability to generate product innovation processes increases 29.12 percentage points, relative to the probability of firms without an R&D team. This result aligns with prior work emphasizing the value of internal R&D teams for supporting firms' innovation outcomes (Lederman, 2010). Dedicating resources to create an R&D team might represent an investment for SMEs. Although the mechanism through which firms integrate their R&D teams is heterogeneous across organizations, recent studies have reported that internal R&D teams are dynamic business units that not only positively impact innovation processes, but also contribute to develop collaboration alliance with potential effects on various business outcomes (Bonaque-Rodríguez et al., 2024; Sjödin et al., 2020). This finding supports hypothesis H2a stating that firms with an internal R&D team are more likely to develop product innovation.

The results for the interaction terms between the R&D team dummy and the variables related to vertical collaborations reveal a less positive case. It was found that internal R&D teams negatively moderate the relationship between strategic collaborations with suppliers and product innovation (Table 2: β_{12}>-0.7788, p-value<0.10). The finding of the marginal effect for this interaction term suggests that for firms actively collaborating with suppliers, having an internal R&D team significantly reduces the probability of developing product innovations 16.74 percentage points, compared to the probability of firms without an R&D team. The findings also indicate that the interaction between the R&D team and vertical strategic collaborations with customers is not statistically significant (Table 2). These results do not support hypothesis **H2b** that proposes that an internal R&D team positively moderates the relationship between strategic collaborations (with suppliers and customers) and product innovation.

All together, the findings suggest a substitution effect between R&D teams and vertical strategic collaborations, especially those developed with suppliers. On the one hand, SMEs without an internal R&D team might rely more on strategic collaboration with suppliers to develop their innovations (Frow et al., 2015; Lafuente et al., 2023). On the other hand, SMEs with the capacity to create an R&D team are in a better position to generate timely communication with the firm's relevant stakeholders—including suppliers and customers—which reduces uncertainty in new product development processes (Wu et al., 2023); as well as to respond more rapidly to changing customer needs via tailor-made solutions (customized products) (Vendrell-Herrero *et al.*, 2021).

The findings presented in this section suggest that in contexts where SMEs lack internal R&D capacities—common in many emerging economies—collaborations with suppliers can serve as a valuable pathway to innovation. On the contrary, SMEs with strong internal R&D capabilities may produce fewer benefits from such partnerships, instead relying on in-house expertise (internal R&D team). While our analysis is based on Latin American SMEs, similar dynamics may apply to SMEs in other developing contexts with resource constraints and uneven digital maturity. In such environments, policymakers and practitioners should tailor innovation support programs to the firm's existing capabilities, balancing incentives for internal R&D investment with the promotion of value-chain collaborations (Lafuente et al., 2023).

4.2 Robustness Test

To further verify the non-significant result for the interaction term between strategic collaborations and R&D teams, a robustness check based on the Kruskal-Wallis test was run to compare the proportion of innovative firms with and without an internal R&D team. Results for the sub-sample of innovative firms are presented in Table 3.

In line with the results of the multilevel regression, results in Table 3 indicate that firms with and without an internal R&D team have similar collaboration patterns. Despite the non-significant results, it was also found that innovative SMEs without an R&D team collaborate more with suppliers than firms that report an R&D team to develop product innovation processes (except for Uruguayan firms). On the contrary, the findings suggest that innovative SMEs with an R&D team tend to generate more strategic collaborations with customers than those without an R&D team (Argentine firms are the only exception to this pattern). These results confirm the paradigm shift in innovation management highlighted by Vendrell-Herrero et al (2023) regarding limitations of traditional closed innovation models, such as internally based R&D vs. open innovation models, where external knowledge sources are effectively used to develop innovations.

Table 3: Kruskal-Wallis test: Distribution of strategic vertical collaborations among innovative firms with and without an internal R&D team

	Innovative firms with R&D team	Innovative firms without R&D team	Kruskal-Wallis test
Panel A: Strategic collaborations with suppliers			
Argentina	0.2857 (0.4688)	0.5714 (0.5136)	2.250
Costa Rica	0.3636 (0.4885)	0.4211 (0.5073)	0.165
Ecuador	0.5500 (0.5038)	0.6429 (0.4972)	0.359
Mexico	0.4000 (0.5026)	0.4737 (0.5130)	0.210
Uruguay	0.2000 (0.4104)	0.1935 (0.4016)	0.003
Full sample	0.3937 (0.4905)	0.4124 (0.4948)	0.079
Panel B: Strategic collaborations with customers			
Argentina	0.3571 (0.4972)	0.4286 (0.5136)	0.144
Costa Rica	0.2424 (0.4352)	0.1579 (0.3746)	0.507
Ecuador	0.4750 (0.5057)	0.2857 (0.4688)	1.491
Mexico	0.2500 (0.4443)	0.1579 (0.3746)	0.494
Uruguay	0.3500 (0.4894)	0.2258 (0.4250)	0.923
Full sample	0.3465 (0.4777)	0.2371 (0.4275)	1.964

Note: For all countries, the result of the Kruskal-Wallis statistic is not statistically significant. Standard deviation is presented in brackets.

5. Discussion

This study investigated how vertical strategic collaborations with suppliers and customers, and the presence of internal R&D teams, affect product innovation among SMEs in five Latin American countries. The Latin American SME context provides an important empirical setting for understanding these dynamics. SMEs dominate the region's industrial structure, representing the majority of enterprises and a substantial share of employment. Yet they face persistent constraints in financing, technological infrastructure, and skilled human capital (Ács et al., 2022). These conditions make collaboration and internal R&D investment critical strategies for developing innovation plans and create or sustain competitive advantage (Laursen & Salter, 2006; Vendrell-Herrero et al., 2021; Lafuente et al., 2023).

The key findings confirm that supplier collaborations and R&D teams each have a positive and significant effect on the likelihood of developing product innovation. External collaborations with value-chain partners can provide access to complementary resources and technical know-how that SMEs cannot generate in-house. Internal R&D teams, by contrast, represent a concentrated capability that enables firms to identify, integrate, and exploit knowledge available within the firm.

However, their joint use reveals a substitution effect: the positive impact of supplier collaborations is weaker for SMEs that possess internal R&D capabilities. The substitution effect identified in the results aligns with theoretical arguments in the resource-based and strategic management views, which posit that firms with strong internal capabilities may have less dependence on external sources for critical knowledge inputs (Laursen & Salter, 2006; Chesbrough, 2010; Hidalgo & Herrera, 2020). In this study, SMEs with dedicated R&D teams may rely primarily on internal expertise, using external partners selectively rather than as primary innovation drivers. Conversely, SMEs without such teams appear to depend more heavily on supplier collaborations to compensate for internal capability gaps. This finding advances prior work by showing that, in resource-constrained contexts, the interplay between internal and external mechanisms is not always complementary, as suggested in much of the open innovation literature (Chesbrough, 2010).

Customer collaborations did not display a significant association with product innovation. This result diverges from studies in developed markets that find strong positive effects from customer involvement (e.g., von Hippel, 2005). In the context of this study, several factors may limit SMEs' ability to translate customer input into successful product outcomes. These include lower absorptive capacity, limited formal processes for capturing and acting upon customer feedback, and market conditions that prioritize cost and operational reliability over continuous product customization (Lafuente et al., 2023). This suggests that the effectiveness of customer collaboration as an innovation driver may be highly contingent on organizational capabilities and market structures.

Overall, the findings presented in this study increase the literature on SMEs' innovation by highlighting the conditional nature of the relationship between external collaborations and internal capabilities. Results suggest that managers should consider their firm's resource profile when deciding whether to invest in building internal R&D teams, pursuing external collaborations, or balancing both.

6. Concluding Remarks, Implications, and Future Research Lines

6.1 Concluding Remarks

The study presented in this research investigated the impact of the strategic connection between R&D teams and vertical collaborations with suppliers and customers on innovation. Specifically, we evaluated two innovation mechanisms: a purely internal process headed by R&D teams, and an externally-enabled innovation process where collaborations with suppliers and customers play a key role. Using an international sample of 477 Latin American SMEs from five countries, the results of the multilevel model revealed a pathway to innovation primarily driven by the development of vertical collaborations with suppliers among SMEs without an internal R&D team. On the contrary, among SMEs with an R&D team, the exploitation of this innovation structure is the main means for explaining their product innovation efforts. The results of the study also highlight, for the sampled SMEs, the low impact that collaborations with customers have on SME's new product developments in certain contexts.

6.2 Implications

The analysis of how internal and externally-enabled innovation configurations support firm's new product development processes bring meaningful implications for academia and practice. The implications discussed in this section emerge directly from the results and are strictly connected to the study's research questions.

In line with the study's first research question ('*Do vertical strategic collaborations with suppliers and customers, as well as R&D teams, impact firms' product innovation?*'), the main lesson drawn from the findings is that when it comes to innovation efforts, strategic networks can be instrumental in supporting co-innovation systems. Such networks appear to bridge partners, facilitate collaboration, and compensate for firms' potential resource deficiencies, aiding them to develop innovation processes. For firms engaging in an innovation strategy based on the exploration of internal knowledge through an internal R&D team, the role often filled by strategic partners in innovation systems is only necessary when such co-innovation collaboration with value-chain partners—in this study, suppliers—offers critical information and resources that will likely improve operational efficiency within firms' ecosystem to better optimize their innovation potential.

Additionally, the results suggesting a substitution effect between exploration strategies based on internal (R&D teams) and external knowledge (co-innovation collaborations) open the debate on how SMEs in developing economies engage in innovation processes, compared to comparable firms in other, more developed contexts. Liabilities of smallness are commonly invoked to explain SMEs limited growth and performance possibilities (Bayon et al., 2016; Lafuente et al., 2019; Runst & Thomä, 2022). However, in this study it is argued that, in light of the new digital reality that is governing

and re-configuring firms' operational processes in both developed and developing contexts (Ács et al., 2022), the limited operational digitalization of SMEs might result in relatively low interconnectedness and engagement with customers which, in turn, leads to the reported null effect of collaborative configurations between R&D teams and customers collaborative over innovation outputs (Lafuente & Vaillant, 2023).

Digitalization facilitates collaborative efforts; therefore, in the absence of consolidated digitalized operations, managers should make an extra effort to add digital competencies that open a window of opportunity for a more customized approach to analyzing innovation in multi-agent relationships, especially with customers. This argument connects to the study's second research question ('*Does the presence of an R&D team moderate the effect of strategic collaborations on product innovation?*').

6.3 Future Research Lines

The findings presented in this study are open to further verification. First, the proposed firm-level analysis does not allow for understanding the decision-making process underlying firms' co-innovation configurations directly. Future work could explore this issue by evaluating micro-foundational and the related decision-making processes impacting the innovation outcomes of SMEs. Second, the type of innovation analyzed in this study is exclusively based on new product developments and reported amendments to existing products. Although this practice is robust and widely used in academic research (e.g., Lafuente et al., 2018), different co-innovation configurations may impact various innovation dimensions, conditional on the profile and purposes of the firm's strategic partners (e.g., suppliers, customers, research institutions, among others) (Bettiga & Ciccullo, 2019; Ozturk et al., 2024).

Finally, future research should analyze the relationship between co-innovation strategies and innovation outcomes in a more significant number of countries. Despite the significant country-specific heterogeneity reported in the study sample, including firms from more countries may better capture the inherent diversity of those in other geographic settings.

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