



The open innovation pathway that boosts the performance and competitive advantage of fruit and vegetable MSMEs

La ruta de la innovación abierta que promueve el desempeño y la ventaja competitiva de las Mipymes hortofrutícolas

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Abstract

Micro, small and medium-sized enterprises (MSMEs) demand dynamic capabilities, such as open innovation, in order to improve their performance and achieve a competitive advantage. Based on a sample of 102 MSMEs that belong to the fruit and vegetable sector in Colombia and through a multivariate analysis with structural equations, it was found that the exploitation activities and entrepreneurial orientation of microentrepreneurs are determinants in the promotion of open innovation. In addition, the mediating role of performance was proven, and a theoretical route was established on the antecedents of open innovation and its enhancement to achieve superior performance and achieve a competitive advantage for fruit and vegetable MSMEs. These findings offer microentrepreneurs theoretical and practical guidance to manage open innovation, allowing them to obtain significant benefits and sustainable competitive advantage.

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Resumen

Las micro, pequeñas y medianas empresas (Mipymes) demandan capacidades dinámicas, como la innovación abierta, con el fin de mejorar su desempeño y alcanzar una ventaja competitiva. Sobre una muestra de 102 Mipymes que pertenecen al sector hortofrutícola en Colombia y mediante un análisis multivariante con ecuaciones estructurales, se encontró que las actividades de explotación y la orientación emprendedora de los microempresarios son determinantes en el fomento de la innovación abierta. Además, se comprobó el rol mediador del desempeño y se estableció una ruta teórica sobre los antecedentes de la innovación abierta y su potenciación para alcanzar un desempeño superior y lograr una ventaja competitiva de las Mipymes hortofrutícolas. Estos hallazgos ofrecen a los microempresarios una guía teórica y práctica para gestionar la innovación abierta, lo que les permitirá obtener beneficios significativos y ventaja competitiva sostenible.

Código JEL: L26, M16, O32

Palabras clave: innovación abierta; desempeño de la empresa; desempeño de la innovación; ventaja competitiva; mipymes

Introduction

According to the Food and Agriculture Organization of the United Nations (FAO) (2020), China, India, the United States, Turkey, Brazil, and Mexico are the world's main fruit and vegetable producing countries. The two Latin American countries rank fifth and sixth, producing 45 and 36 million tons annually, respectively, while Colombia produces 13 million tons (Asohofrucol, 2022; Spanish: Asociación Hortifrutícola de Colombia). Nonetheless, Colombia's fruit and vegetable sector has a share of 21% of the total production of the agricultural sector (Asohofrucol, 2022). This poses a contradiction because although this sector is considered strategic for the country, there are still obstacles derived from the scarcity of resources and the lack of innovation.

Ragazou et al. (2022) pointed out that research on this topic suggests regional dualities deepening according to progress in innovation. In response to this situation, developing countries seek to effectively influence Agricultural Innovation Systems to create environments and linkages conducive to innovation where leveraging external knowledge becomes a critical pillar for MSMEs to achieve meaningful progress in innovation (Ragazou et al., 2022). Current models of agricultural innovation emphasize collaborative innovation strategies with close and frequent interactions that facilitate the transfer of tacit knowledge. Hence, innovation-oriented collaboration is embodied in open innovation practices (Cholez et al., 2023).

According to Chesbrough and Bogers (2014), open innovation benefits companies by helping them overcome constraints and respond nimbly to environmental changes. This approach allows them to leverage and absorb external knowledge to achieve successful business outcomes and maintain a sustainable competitive advantage (Lee & Yoo, 2019). Therefore, open innovation becomes particularly relevant for those companies facing human and financial resource constraints, as is often the case for fruit and vegetable MSMEs (Torchia & Calabrò, 2019).

Open innovation is the capacity to manage knowledge flows from internal and external sources (Chesbrough, 2003), leveraged on various forms of network collaboration, including associations, agricultural research centers, universities, guilds, suppliers, customers, and farmers. Thus, due to the nature of the environments and the interests of the actors, open innovation is characterized by its dynamics because, as pointed out by the theory of resources and capabilities, both internal and external knowledge are valuable, rare, imperfectly imitable, and non-substitutable resources (Barney, 1991).

Given the above, opinions regarding the potential of dynamic capabilities to generate a sustainable competitive advantage have given rise to interesting academic controversies about the mechanisms that enable their development (Teece, 2023; Pundziene et al., 2022). While it is a fact that both research that has empirically tested the effect of open innovation on competitive advantage and empirical evidence in the fruit and vegetable sector in developing countries are scarce (Echeverri-Romero et al., 2022; Houessou et al., 2023), there are sources in the scientific literature that demonstrate that open innovation can contribute to companies achieving competitive advantage, provided they have previously achieved successful performance (Skordoulis et al., 2020). Nevertheless, research on this topic in the SME range has yielded mixed results (Tagoe et al., 2022; Tsai et al., 2022).

In the work of Malodia et al. (2023), it can be seen that in the few studies that focus on the antecedents and factors that drive the efficient management of open innovation in MSMEs, the importance of skills related to exploitation activities to effectively capture the benefits of knowledge flows within the management toolbox for micro-entrepreneurs in the fruit and vegetable sector is highlighted. It is also added that a strong entrepreneurial orientation that enables microentrepreneurs to reap the benefits of openness to innovation must incorporate characteristics such as innovativeness, proactivity, and willingness to take risks (Zighan et al., 2022).

With this in mind, this paper aims to demonstrate how open innovation and performance play a mediating role between entrepreneurial orientation and exploitation activities to achieve a sustainable competitive advantage for MSMEs in the fruit and vegetable sector. This study is expected to contribute to expanding empirical knowledge on the antecedents, effects, and dynamic nature of open innovation on competitive performance.

The literature justifies and supports this study's need and innovation. Therefore, this study is a response to the call of some scholars (Teece, 2023) to identify new and effective ways to improve the innovation capacity of MSMEs to achieve competitive advantage (Lima Rua et al., 2023). The debate on the effectiveness of open innovation in management in MSMEs is ongoing, and researchers have not reached a consensus on the best model for managing open innovation (Lima Rua et al., 2023).

This paper is structured as follows: first, the theoretical background and key concepts are presented. Next is a description of the methodology and a synthesis of the results. Finally, the results, the theoretical and practical implications, and the research limitations are explained.

Open innovation in MSMEs in the fruit and vegetable sector

Dynamic capabilities reflect a company's potential to solve problems, given its propensity to identify opportunities and threats, to make timely market-driven decisions, and to change its resource base (Lima Rua et al., 2023). Arranz et al. (2020) highlight that open innovation is a dynamic capability that encompasses the ability to identify new partnership opportunities and external knowledge sources, take advantage of such opportunities, and finally, transform internal and external resources, resulting in competitive advantages (Teece et al., 2016).

Initially, research on open innovation focused on large, high-tech companies (Chesbrough, 2003). Nevertheless, as research has progressed, this approach has also begun to be applied to SMEs. The first studies on open innovation in SMEs were conducted by Vrande et al. (2009), and since then, the research and experts dedicated to this field have increased in number (Radziwon & Bogers, 2019; Tsai et al., 2022). For fruit and vegetable MSMEs, studies on open innovation are insufficient. The existing ones have been essentially focused on case analyses (Echeverri-Romero et al., 2022) and technologies such as genetic improvement (Ahrolovich et al., 2020), blockchain (Borrero, 2019), IoT, big data, and artificial intelligence (Misra et al., 2020), and on Industry 4.0 in general (Silva et al., 2023).

In the Latin American context, studies in the agricultural sector stand out, especially in Brazil, where it is evident that open innovation practices have been carried out through agricultural innovation ecosystems (Barzola Iza et al., 2020), Industry 4.0 (Romani et al. 2021), and the development of smart agriculture comprising precision agriculture, information technologies, and agricultural management information systems (Pivoto et al. 2019). Regarding the sources from which farmers obtain external knowledge, public universities, the Brazilian Agricultural Research Corporation (Embrapa; Portuguese: Empresa Brasileira de Pesquisa Agropecuária), and private foundations are among the most prominent (Pivoto et al. 2019).

Johnson (2017) stated that Mexican production of some fruits and vegetables (tomatoes, peppers, cucumbers, berries, and melons) had increased significantly in recent years, largely due to Mexico's investment in large-scale greenhouse production facilities and other technological innovations. Castro Perdomo et al. (2018) conducted a study in Ecuador to assess how open innovation could improve agricultural production. They found that although the agricultural sector (bananas, coffee, and rice) has a natural potential to increase production levels, it lacks incentives and infrastructure for the management of science and technology, as well as sophisticated human capital.

In Colombia, although there is no evidence of studies on particular innovations in the fruit and vegetable sector, according to Asohofrucol (2022), open innovation has been deployed in technical assistance, technological models, crop lags, farms adapting to climate change, and technology transfer through farmer field schools. Regarding the sources of knowledge, according to Silva-Castellanos (2021), the actors with which the fruit and vegetable sector is related are the farmers' associations, the trade association ASOHOFRUCOL, the Colombian Agricultural Research Corporation (AGROSAVIA; Spanish: Corporación Colombiana de Investigación Agropecuaria), and the National Learning Service (SENA; Spanish: Servicio Nacional de Aprendizaje).

It can be inferred that open innovation is a natural practice in agricultural MSMEs in some Latin American countries and occurs, according to De Martino and Magnotti (2018), for two main reasons. First, the innovations they develop are usually incremental and are carried out in collaboration with buyers, suppliers, and other business partners. Second, since MSMEs lack sufficient financial resources, labor, and infrastructure, they must rely on external sources for their innovative processes. Therefore, inquiring into the antecedents that foster open innovation in MSMEs remains the focus of academic research and a critical input for policy initiatives to stimulate economic development in emerging markets.

Exploitation activities as an antecedent of open innovation in MSMEs

Exploitation can be defined as the ability to improve, implement, and expand existing knowledge and agricultural products and processes. Exploitation expands the existing knowledge and skills of microentrepreneurs and improves established production processes and increases their efficiency (Zakić & Milovanović, 2017). Therefore, it can be noted that agricultural innovations are formed with existing knowledge and strengthen farmers' existing processes and skill structures (Jansen et al., 2006).

Exploitation has often been investigated at the company level (Lubatkin et al., 2006) or at the business unit level (Jansen et al., 2006). Nonetheless, there is a lack of conceptual understanding and empirical validation of exploitation across microfoundations (Ali et al., 2020). In this regard, Iqbal et al.

(2023) emphasize the importance of assessing exploitability at the individual level of micro-entrepreneurs, as they are the ones who adopt and implement open innovation activities in fruit and vegetable MSMEs.

According to March (1991), the microentrepreneur's exploitation activities involve using, reusing, and refining existing knowledge to improve products and processes and obtain value from what is already known. Exploitation is characterized by its short-run focus, efficiency, implementation, execution, and development based on existing beliefs and decisions (Vrontis et al., 2019). So far, few studies have assessed how individual farm activities influence several variables in fruit and vegetable MSMEs (Vrontis et al., 2019). Silva-Castellanos (2021) demonstrated that operating activities promote the ability to manage internal and external knowledge in fruit and vegetable SMEs. Consequently, based on these findings, the following hypothesis was proposed:

Hypothesis 1. The microentrepreneur's exploitation activities positively affect the ability to manage open innovation.

Entrepreneurial orientation as an antecedent of open innovation in MSMEs

Entrepreneurial orientation is characterized by a willingness to take risks, a proactive search for opportunities, and participation in innovative processes (Freixanet et al., 2021). Microentrepreneurs with a more pronounced entrepreneurial orientation tend to adopt proactive and entrepreneurial approaches, showing greater receptivity and compatibility with external knowledge to benefit more effectively from innovation activities (Hung & Chiang, 2010). A pioneering study in establishing a relation between these two variables was conducted by Hung and Chiang (2010), who emphasized that a greater entrepreneurial orientation leads to greater benefits through open innovation.

Companies with a strong entrepreneurial orientation constantly explore, monitor, and interact with the external environment to find new solutions and opportunities and strengthen their competitive position (Chen et al., 2019). According to Ginting (2015), agricultural micro-entrepreneurs must improve their ability to streamline products and processes to provide them with added value and increase their intensity to explore a global market with great potential. To enter this market, business entrepreneurs must have a strong entrepreneurial orientation; that is, they must be willing to take risks, be proactive, independent, and able to compete aggressively. Studies (Echeverri-Romero et al., 2022; Ince et al., 2023) demonstrate the influence of entrepreneurial orientation on how MSMEs grant legitimacy to open innovation. Under these premises, it is possible to postulate that:

Hypothesis 2. The entrepreneurial orientation of microentrepreneurs positively affects the ability to manage open innovation.

The mediating role of performance in open innovation and competitive advantage

According to Teece (2023), the academic debate on whether dynamic capabilities generate competitive advantage is still open. Nevertheless, the available evidence in the literature, both theoretical and empirical, has consistently established that dynamic capabilities—such as open innovation—generate a strong and positive nexus with SME performance (Pundziene et al., 2022). Subsequently, a sustainable competitive advantage is achieved.

The research in this paper assessed two aspects of performance: innovative performance and organizational performance. Innovative performance refers to MSMEs' success in introducing innovations, such as new products and processes, exploring unknown markets, and new ways of organizing the fruit and vegetable business model (Tagoe et al., 2022). Organizational performance encompasses the results of the MSME, such as financial performance, sales volume, growth rate, and reputation in the market (Singh et al., 2021).

Compared to large companies, MSMEs tend to rely more on open innovation because their internal R&D resources are scarce. These companies cannot significantly improve their innovative performance through internal R&D activities alone (Tagoe et al., 2022). Previous research has shown a strong association between open innovation and the performance of companies (Fu et al., 2019; Lu et al., 2023). Particularly in the agribusiness sector, there is some significant research (Toth & Fertő, 2017) showing that the more open the innovation, the higher the innovative performance of SMEs.

Nevertheless, there is still a gap in understanding how fruit and vegetable MSMEs can improve open innovation management capabilities and transform their openness into tangible outcomes (Torchia & Calabrò, 2019). In this regard, some researchers have demonstrated the indirect effect of innovative performance on the nexus between open innovation and organizational outcomes (Singh et al., 2021; Hameed et al., 2021; Nazari et al., 2021). That is, new capabilities acquired by fruit and vegetable MSMEs through open innovation when they combine internal and external resources are converted into new products and processes, which will be reflected in superior organizational performance (Hameed et al., 2021).

Consequently, open innovation increases the ability of companies to take advantage of opportunities from external knowledge sources, which can have a significantly positive impact on new product development, innovation returns, and sales growth (Boudreau, 2010; Chesbrough & Crowther, 2006). This can subsequently be transformed into a sustainable competitive advantage. Little is known in the literature about how open innovation becomes a competitive advantage for SMEs (Echeverri-Romero et al., 2022; Sulistyo & Ayuni, 2020; Lee & Yoo, 2019).

Competitive advantage is based on the execution of a strategy that is not being implemented by competitors, which makes it possible to reduce costs, take advantage of opportunities, and neutralize risks (Barney, 1991). This advantage materializes when resources are unique, rare, difficult to reproduce, and the cost of having or using them is very high, which creates a barrier against competitors imitating or substituting them. Wernerfelt (1984) formalized this perspective through a resource-based approach. Nonetheless, MSMEs face the challenge of limited resources, which tends to constrain their sources of competitive advantage (Echeverri-Romero et al., 2022).

According to Lima Rua et al. (2023), SMEs need to identify and understand trends in emerging technologies and expand their technical knowledge base to develop and maintain cutting-edge technologies that create a competitive advantage. Innovative companies' introduction of unique products or services enables them to achieve business results and become more competitive and successful than their competitors (Musiello-Neto et al. 2021). Conversely, the literature recognizes that organizational performance is related to competitive advantage (Suwandana, 2023; Khan et al., 2019). Studies on how open innovation management forms a competitive advantage are insufficient (Liu & Yang, 2019; Echeverri-Romero et al., 2022). At the same time, Singh et al. (2021) estimate that open innovation triggers competitive advantage, provided that the MSME has previously obtained superior performance. Therefore, it is postulated that:

Hypothesis 3. Innovative performance and organizational performance play a multiple sequential mediating role in the nexus between open innovation and competitive advantage.

Multiple sequential mediating effect of open innovation and performance

A sound strategic approach enables MSMEs to build long-run competitive advantages by incorporating knowledge and technological skills through introducing new ideas into innovative products, processes, and business models. This knowledge benefits the organization and fosters economic growth. Barney (1991) argued that a company's resources must be managed in such a way that they become competitive advantages. Open innovation can revitalize MSME's competencies as a dynamic capability, generating innovative responsiveness and improved business performance (Teece et al., 1997; Ojha et al., 2020).

Some empirical studies have demonstrated the sequential and mediating effect of open innovation and performance. For example, Chabbouh and Boujelbene (2020) revealed that SMEs' human capital strongly influences innovative performance and overall company performance through the mediating role exerted by open innovation. Tian et al. (2021) found that the mediating role of openness to knowledge further strengthens the relation between network integration and innovative performance of

SMEs. Tsai et al. (2022) found that reverse knowledge sharing has a mediating effect on the relation between open innovation and SME performance.

As evidenced by the above studies, although open innovation practices produce results, they cannot achieve a solid competitive advantage in the long run. According to organizational learning theory (March, 1991), companies engage in open innovation activities to obtain external innovation resources, which requires them to perform exploitation activities beforehand. Hwang et al. 2023 found that open innovation plays a moderating role in the relation between exploitation and company performance. According to Shi et al. 2020, it can be seen that exploitative learning capability is a factor that completely impacts the trajectory of open innovation activities.

Nevertheless, the current literature contains a limited number of studies that address the sequential spillover effects of open innovation and performance on competitive advantage and exploration. Therefore, this is a pertinent contribution to the body of knowledge that clarifies how exploitation affects the open innovation activities and superior performance of MSMEs in different aspects, producing sustainable competitive advantages in the long run. Based on the above, it can be postulated that:

Hypothesis 4. Open innovation, innovative performance, and organizational performance play a multiple sequential mediating role in the exploitation-competitive advantage nexus.

Along the same lines, it has been established that the practices of microentrepreneurs associated with open innovation imply a propensity to take risks and be proactive and innovative. Therefore, the role of entrepreneurial orientation is to drive open innovation to obtain better results, which are subsequently transformed into a sustainable competitive advantage. Ul Hassan and Iqbal (2020) found that entrepreneurial orientation, organizational structure, and information and communication technologies impact open innovation, which directly and through moderating the innovative climate affects the company's innovative performance. Entrepreneurial orientation can increase open innovation intensity and performance (Sulistyo & Ayuni, 2020), i.e., they can play a mediating role between entrepreneurial orientation and competitive advantage. Therefore, it can be also proposed that:

Hypothesis 5. The nexus between entrepreneurial orientation and competitive advantage is sequentially and multiply mediated by open innovation, innovative performance, and organizational performance.

Methodology

It is more and more frequently found that open innovation is becoming a topic of interest for SMEs in Latin America. Specifically, in the case of the agricultural sector, studies have been concentrated in Brazil.

Hence, more research is needed on open innovation in other Latin American countries, especially in the fruit and vegetable sector (Silva-Castellanos, 2021). This is because, according to the analysis of Asohofructol (2022), Latin America and the Caribbean are considered the most important fruit-exporting regions in the world, producing most of the banana, mango, pineapple, avocado, and papaya consumed worldwide.

Colombia is of great importance in the fruit and vegetable sector worldwide, as it contributes 5% of the world's avocado production and most of the passionflower species, with about 167 genotypes (Fontagro, 2020). Therefore, it is worth investigating the new models of innovation that allow the companies to become more competitive, innovative, and dynamic in the MSMEs of Colombia's fruit and vegetable sector.

The data for this study were obtained from 102 micro-entrepreneurs in Colombia's fruit and vegetable sector. According to Fontagro (2020), 50% of these crops in developing countries are subsistence crops cultivated by small farmers. The sampling frame was the MSMEs in Valle del Cauca, a region with a 6% share of the total area planted nationwide (Asohofructol, 2022). A self-administered questionnaire designed particularly for this study was used to collect the required data, which was validated through an in-depth review of the existing literature. Previously, a pilot test was conducted with 10 microentrepreneurs to evaluate its suitability and make the necessary adjustments.

Table 1 shows details of the resulting sample. The study revealed that in the fruit and vegetable MSMEs, the majority of the managers are men, between 42 and 60 years old, comprising 63% of the participants. 70% of the MSMEs sell less than USD 1 000 of their products per month. These MSMEs are relatively mature with more than 8 years of incorporation. Only 18% of them export, and their capacity to manage open innovation primarily focuses on production processes. It was found that 69% of the MSMEs were affected by COVID-19 in sales and income, which reduced their customers and increased their costs.

Table 1
 Characteristics of fruit and vegetable MSMEs.

Experience in agricultural activity	Percentage	Monthly sales range	Percentage
Between 1 and 3 years	8%	Less than USD 235	44%
Between 3 and 5 years	4%	Between USD 235 and 705	28%
Between 5 and 8 years	5%	Between USD 705 and 1175	13%
More than 8 years	82%	Between USD 1175 and 1880	2%
Less than 1 year	1%	Between USD 1880 and 2350	6%
Belongs to an association	Percentage	More than USD 2350	7%
No	28%	Has the company carried out export processes?	Percentage
Yes	72%	No	82%

Type of innovation carried out	Percentage	Yes	18%
Products	8%	Exported products	Percentage
Production processes	82%	Avocado	62%
Administrative or management processes	6%	Coffee	12%
Marketing	4%	Soursop	5%
Coronavirus Consequences	Percentage	Papaya	11%
Sales	44%	Banana	5%
Revenue	38%	Grape	5%
Decrease in Customers	29%	Does the company know the National Agricultural Innovation System?	
Costs	27%	No	89%
Increase in expenses	20%	Yes	11%
Dismissal of employees	17%		
Low bargaining power with suppliers	15%		
Increase in taxes	4%		
Others	11%		

Source: created by the authors.

Metrics

Independent variables: Exploitation (Spanish: Explotación) was defined as innovative activities based on knowledge that already exists and is available to the MSME. In other words, the company does something new based on the knowledge of already existing product(s) or technology(ies). The Mom et al. (2009) scale was adapted, which originally included 7 items, but 2 items were discarded because the factor loadings were below 0.5 (Hair et al., 1998). The items included were: EXPLOT3: activities in which you serve existing customers with existing services or products; EXPLOT4: activities in which it is clear to you how to handle them; EXPLOT5: activities mainly focused on achieving short-term goals; EXPLOT6: activities in which you can perform appropriately by using your current skills; EXPLOT7: activities in which you can adjust to those that already exist in the company.

Entrepreneurial orientation (Spanish: Orientación Emprendedora) defined the company's strategy to engage in technological innovations, undertake high-risk ventures, and proactively seek opportunities. The Hung and Chiang (2010) scale was used, composed of 8 items, of which 2 items were discarded (factor loading less than 0.5). The items included were OE2: changes in products, services, administrative techniques, or processes in the company are entirely new; OE4: the company is often the first to introduce new products, services, administrative techniques, or processes; OE5: the company generally adopts a very competitive stance; OE6: the company leader can take high risks in implementing new processes that help obtain higher returns; OE7: the company has a good reputation in the marketplace; OE8: in the face of uncertain situations, the company usually adopts a bold stance to take advantage of opportunities.

Dependent variables: Open innovation in the Colombian fruit and vegetable sector is defined as the efforts made by a company to seek new ideas and external knowledge from associations, public organizations, customers, and the community. The scale established by Chesbrough (2003, p.26) and Hung and Chiang (2010) was modified into 10 items to measure open innovation. Nevertheless, only 5 items had the minimum factor loadings: INNA5: the company does not have to originate research to take advantage of it; INNA6: to build a good business model, the company needs to use some ideas obtained outside the company; INNA8: the company benefits from others using and acquiring its knowledge; INNA9: to benefit from innovation, the company needs to use the knowledge generated by others; INNA10: the company should buy the knowledge developed by others as long as it represents a breakthrough for the company.

The variables innovative performance (Spanish: Desempeño Innovador) and organizational performance (Spanish: Desempeño Organizacional) were measured using the Frances and Fortuin (2009) scales. They were operationalized as the respondent's subjective assessment of the company's innovativeness in the fields of DI1: marketing, DI2: product design, DI3: product quality, DI4: distribution and production DI5: product acceptance before the competition; and DI7: the result of the resources invested in research processes. The organizational performance was operationalized as DO2: position, DO3: profitability, DO4: sales volume, DO5: growth rate, DO6: financial strength, and DO7: reputation in the market, all items being compared with the main competitors.

Competitive advantage (Spanish: Ventaja Competitiva) refers to a comparatively superior market position that allows an MSME to outperform its competitors. The scale McGrath et al. (1996) developed was adapted for competitive advantage; item VC4 was discarded because its factor loading was less than 0.5. VC1: The company has a faster and more effective response than its competitors; VC2: The company delivers higher value products than its competitors; VC3: The company is more efficient than its competitors; VC5: In short, it has a competitive advantage over its rivals.

Control variables: age of the company, internationalization, and sales range, and the dichotomous variable COVID-19 was added because studies were found in the literature that showed how COVID-19 had affected global agricultural chains (Tougeron & Hance, 2021).

SmartPLS software, widely recognized and used in structural equation modeling studies, was used for data analysis. The questionnaire given to the participants followed a 7-point Likert scale format.

Validation instrument

The constructs used in this study are reflective and obtained a factor loading above the minimum (> 0.5) (Hair et al., 1999). The internal reliability of the constructs was evaluated using Cronbach's alpha

coefficient (1994), with a minimum acceptable value of 0.70. Under the criteria of Fornell and Larcker (1981) (0.70 CRI, Composite Reliability Index, and 0.5 for AVE, Average Variance Extracted), all constructs exceeded the minimum internal reliability and convergent validity values, as evidenced in Table 2.

Table 2
Construct Reliability and Convergent Validity.

Exploitation (EXP) $\alpha = 0.840$; CR = 0.766 ; AVE = 0.514							
Items	EXPLOT3	EXPLOT4	EXPLOT5	EXPLOT6	EXPLOT7		
Loading	0.596	0.752	0.709	0.676	0.832		
Entrepreneurial Orientation (OE) $\alpha = 0.921$; CR = 0.898 ; AVE = 0.663							
Items	OE2	OE4	OE5	OE6	OE7	OE8	
Loading	0.717	0.766	0.881	0.777	0.823	0.905	
Open Innovation (INNA) $\alpha = 0.878$; CR = 0.828 ; AVE = 0.591							
Items	INNA5	INNA6	INNA8	INNA9	INNA10		
Loading	0.721	0.747	0.719	0.838	0.813		
Innovative Performance (DI) $\alpha = 0.917$; CR = 0.893 ; AVE = 0.612							
Items	DI1	DI2	DI3	DI4	DI5	DI6	DI7
Loading	0.780	0.819	0.808	0.828	0.783	0.766	0.680
Organizational Performance (DO) $\alpha = 0.920$; CR = 0.895 ; AVE = 0.657							
Items	DO2	DO3	DO4	DO5	DO6	DO7	
Loading	0.812	0.821	0.854	0.827	0.761	0.784	
Competitive Advantage (VC) $\alpha = 0.879$; CR = 0.817 ; AVE = 0.646							
Items	VC1	VC2	VC3	VC5			
Carga	0.770	0.785	0.832	0.826			

Source: created by the authors.

Furthermore, applying the more stringent HTMT (Heterotrait-Monotrait) criteria (Henseler et al., 2016), all HTMT values are less than 1, so all constructs achieve discriminant validity.

Structural model assessment

According to the R2 results, exploitation and entrepreneurial orientation explain 25% of the variance of open innovation. Open innovation and organizational performance explain 63.2% of the variance of competitive advantage. The F2 values for open innovation and antecedents are small, moderate for open innovation and innovative performance, and large for organizational performance and competitive advantage. Likewise, the model exhibits an acceptable fit by meeting the SRMR indicator of 0.08 (Hu & Bentler, 1999), a Chi-square of 1117.289, and an NFI of 0.604.

A bootstrapping process was carried out to estimate the significance of the direct effects of the model (5 000 samples). Hypotheses are tested with a T-value >1.96 and a P-value <0.05. Nonetheless,

some researchers in the social sciences prefer a T-value >1.65 with a significance level of 10% (Hair et al., 1999). Entrepreneurial orientation and exploitation were found to affect open innovation positively; for both variables, the significance level was set at 5%. The least strong relation was the relation between exploitation activities and open innovation.

It was also found that some control variables affected the model's results. Sales (VEN; Spanish: Ventas) positively and significantly affected performance. Company age (EDE; Spanish: Edad de la Empresa) negatively affected innovative performance; internationalization (INT) negatively affected organizational performance. At the exploratory level, COVID-19 (CV) positively affected innovative performance, and age (EDE) negatively affected competitive advantage.

Table 3
 Results of the hypotheses and direct effects.

CON S	Hypothesis - direct effects	C/N C	R ²	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P- Values	2.5 %	97.5 %	f2
INN A	H1: EXP -> INNA	C	0.25 5	0.261	0.107	2.433	0.015* *	0.06 4	0.48 1	0.06 2
	H2: OE - -> INNA	C		0.309	0.117	2.644	0.008* **	0.07 4	0.52 6	0.08 7
DI	INNA -> DI			0.476	0.086	5.541	0.000* **	0.31 1	0.64 4	0.29 6
	EDE -> DI			-0.192	0.078	2.451	0.0014 **	- 0.34 1	- 0.02 9	
	VEN -> DI		0.27 7	0.205	0.078	2.632	0.009* **	0.04 4	0.35 1	
	CV-> DI			0.161	0.094	1.721	0.085* *	- 0.03 0	0.33 4	
	INT-> DI			-0.065	0.076	0.856	0.392	- 0.21 9	0.07 7	
DO	INNA -> DO			-0.041	0.093	0.441	0.659	- 0.21 8	0.14 3	0.00 2
	DI -> DO		0.46 5	0.620	0.073	8.478	0.000* **	0.47 4	0.76 0	0.52 0
	EDE -> DO			-0.083	0.073	1.129	0.259	- 0.22 7	0.06 0	
	VEN -> DO			0.178	0.086	2.062	0.039* *	- 0.00 3	0.33 8	

	CV -> DO	0.007	0.078	0.084	0.933	- 0.14 0	0.16 8	
	INT -> DO	-0.141	0.067	2.091	0.037* *	- 0.27 4	- 0.00 8	
	INNA -> VC	0.278	0.063	4.438	0.000* **	0.15 4	0.40 1	0.18 5
	DO -> VC	0.662	0.065	10.215	0.000* **	0.52 4	0.78 1	0.96 9
	EDE -> VC	-0.090	0.051	1.741	0.082* *	- 0.19 2	0.01 2	
VC	VEN -> VC	0.63 2	0.050	0.063	0.805	0.421	- 0.07 8	0.17 1
	CV -> VC	0.066	0.067	0.989	0.323	- 0.06 3	0.20 1	
	INT -> VC	-0.016	0.074	0.212	0.832	- 0.16 5	0.12 9	

Control variables: EDE: Age of the company, VEN: Sales range, INT: Internationalization, CV: COVID-19.

Source: created by the authors.

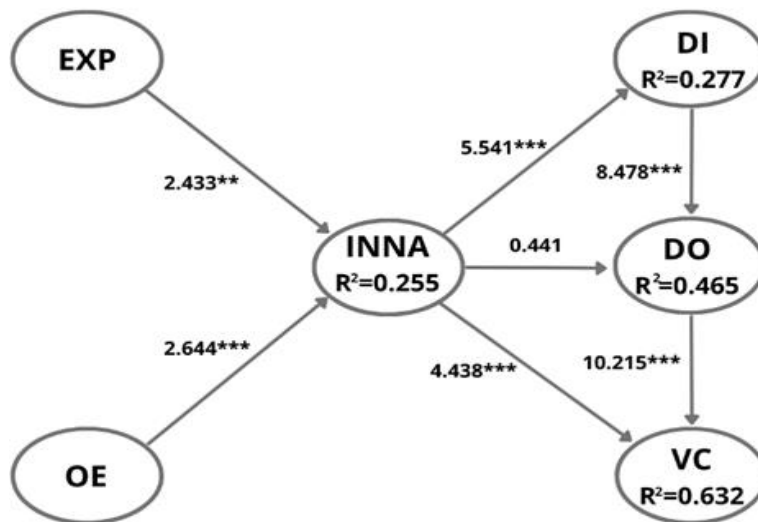


Figure 1. Results of the Model.
 Source: created by the authors.

Indirect effects

Following Hair et al. (2016), mediation occurs when the indirect effect is significant. Table 4 demonstrates that the multiple sequential mediation of open innovation management and innovative performance is significant for the relation between organizational performance and competitive advantage ($\beta = 0.195$, $t = 4.150$; $LL = 0.111$, $UL = 0.297$). Therefore, hypothesis 3 is proved. The findings prove hypothesis 4 ($\beta = 0.051$, $t = 2.085$; $LL = 0.011$, $UL = 0.108$) as they show the sequential significant impact of exploitation activities on open innovativeness, innovative performance, organizational performance, and competitive advantage. At the exploratory level, hypothesis 5 was proved ($\beta = 0.060$, $t = 1.858$; $LL = 0.011$, $UL = 0.137$), indicating that the entrepreneurial spirit of the microentrepreneur affects the open innovation management and the innovative and organizational performance of the company, thereby forging a sustainable competitive advantage.

Table 4
Indirect effects.

Hypothesis - indirect effects	C/NC	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P-Values	2.5%	97.5%
INNA -> DI ->DO		0.295	0.067	4.434	0.000***	0.178	0.443
OE -> INNA->CV		0.086	0.041	2.091	0.037**	0.016	0.176
H3: INNA -> DI -> DO -> VC	C	0.195	0.047	4.150	0.000***	0.111	0.297
H4: EXP -> INNA -> DI -> DO -> VC	C	0.051	0.024	2.085	0.037**	0.011	0.108
H5: OE -> INNA -> DI -> DO -> VC	C	0.060	0.032	1.858	0.063*	0.011	0.137

Source: created by the authors.

Discussion

Although previous studies have extensively discussed the effects and consequences of dynamic capabilities in terms of direct (Teece, 2007; Wang & Ahmed, 2007; Teece, 2023) or indirect (Zahra et al., 2006) effects on competitive advantage, few studies have considered that through performance, open innovation generates a competitive advantage in fruit and vegetable MSMEs. Using structural equations, a model was tested to fill this gap with data collected from 102 micro-entrepreneurs of fruit and vegetable MSMEs, making a theoretical contribution to the postulates of Teece (2014) regarding the fact that dynamic capabilities do create sustainable competitive advantages directly and through the mediating role played by performance.

Hypothesis 1 receives strong support as the coefficient is positive ($\beta = 0.261$) and significant ($p < 0.1$). This shows that exploitation activities promote open innovation. The result is consistent with that found by previous research confirming that micro-entrepreneurs in the fruit and vegetable sector prefer to exploit innovation and expand their existing skills through knowledge flows, thus improving their established production processes (Zakić et al., 2017; Silva-Castellanos, 2022). Descriptive data show that fruit and vegetable micro-entrepreneurs incrementally perform innovation in productive processes by seeking to learn from the success or failure of their main sources of knowledge. Colombia is a technology-driven country where incremental innovation prevails (Ramos Ruiz et al., 2018).

Generally, the sources of knowledge for fruit and vegetable MSMEs are informal (Ginting, 2015). Microentrepreneurs prefer to have associations to absorb the existing knowledge of their peers. The descriptive data show that more than 70% of the MSMEs belong to an association. That means that these MSMEs, in contrast to agro-industrial SMEs in Colombia (Ramos Ruiz et al., 2018), do interact with external agents and that microentrepreneurs are always active in supporting new ideas, experiments, and processes with the existing technology they know to accelerate their innovation capacity. This is an interesting outcome for open innovation promoters because exploitation allows microentrepreneurs to collaborate with existing partners to search for new knowledge (Chesbrough & Prencipe, 2008).

Hypothesis 2 was also proved, which states that the entrepreneurial spirit of the microentrepreneur positively and significantly affects the capacity to manage open innovation ($\beta = 0.309$, $t = 2.644$), coinciding with the results of other researchers (Hung & Chiang, 2010; Echeverri-Romero et al., 2022; Freixanet et al., 2020). Fruit and vegetable MSMEs are more willing to venture into the unknown and develop the capacity to manage open innovation. A more open approach will allow them to use external technological opportunities to improve their business model. The more entrepreneurially oriented the microentrepreneurs are, the more they are willing to take risks, inclined to be innovative and proactive, and take strategic actions to foster, obtain, and share new knowledge. Conversely, microentrepreneurs with a low entrepreneurial orientation tend to be reactive, risk-averse, and imitative of their competitors.

Hypothesis 3 proposed a mediating effect of innovative performance and organizational performance on the relation between open innovation and competitive advantage (see Table 4). To arrive at this mediating effect, it was first found that open innovation did not have a direct and positive relation with organizational performance, contrary to the findings of other researchers who show a positive effect (Chesbrough & Crowther, 2006). Many companies embrace open innovation, seeking to improve their business results, although this is not enough. According to Tsai et al. (2022), the result can be explained by the scarcity of resources, an inadequate innovation strategy, and culture.

It was proved that innovative performance has a highly significant positive effect on organizational performance and that open innovation has a highly significant positive effect on innovative

performance. In other words, innovative performance is a mediating variable between the open innovation and organizational performance relation. These findings are consistent with Hameed et al. (2021), Nazari et al. (2021), and Freixanet et al. (2020). Consequently, the ability of MSMEs to generate new products, markets, and processes directly impacts their organizational performance (Lu et al., 2023; Lazzarotti et al., 2015).

Moreover, it was found that organizational performance positively and significantly affects competitive advantage, with t -value = 10.215 being the highest of all the relations. In this regard, it is recognized that open innovation promotes innovative results, generating superior business results that translate into competitive advantage. Therefore, H3 is supported. Microentrepreneurs who are always looking outside their boundaries for innovative ideas will succeed in creating new processes, products, markets, and administrative forms that will stimulate growth, sales, profits, and their competitive power by fostering high-performance and sustainable competitive advantages. This finding allows scholars who have not found a direct relation between open innovation and organizational performance to have some insight into the variables that play a mediating role.

In the face of multiple sequential effects, by confirming hypothesis 4, it is established that exploitation stimulates open innovation, leading to improvements in innovation and business indicators that create a competitive advantage. Likewise, hypothesis 5 was proved: entrepreneurial orientation generates the same result as exploitation activities, but its effect is smaller. The results show that microentrepreneurs who expand their knowledge, improve their existing skills, innovate from existing technology, dare to take risks, and are always active and innovative will have greater success, a significant increase in performance, and a comparatively higher position.

On the other hand, the study revealed that open innovation significantly impacts competitive advantage ($\beta = 0.278$, $t = 4.438$). This shows that dynamic capabilities do generate a sustainable competitive advantage directly (Echeverri-Romero et al., 2022) and indirectly. Additionally, it was found that the higher the sales, the higher the innovative performance and the better the organizational performance will be, as the company will have the resources to innovate. It is observed that the older the company, the lower the innovative performance. According to Chen et al. (2019), younger companies tend to be more organic and dynamic in pursuing innovation activities. For its part, internationalization negatively affected organizational performance because the internationalization of fruit and vegetable MSMEs is not yet fully developed.

Conclusions

This paper proposed a research model that examines and validates the link between open innovation, performance, and competitive advantage by using the theory of dynamic capabilities. It contributes to the

literature on managing open innovation in developing countries' fruit and vegetable sector. The study findings answer the research question: How do open innovation and performance play a mediating role between entrepreneurial orientation, exploitation activities, and performance in achieving competitive advantage for fruit and vegetable MSMEs?

The microentrepreneur's exploitation activities, i.e., the improvement and refinement of existing knowledge and the application of incremental innovation, drive the successful management of internal and external knowledge. Similarly, a high level of entrepreneurial orientation of the microentrepreneur, i.e., a good attitude toward innovation, assimilating risks, and being proactive, positively affects the outflow and inflow of knowledge. Therefore, if microentrepreneurs work on entrepreneurial orientation and perform exploitation activities, they will adopt open innovation activities that improve organizational performance and competitive advantage.

MSMEs engage in open innovation skills seeking to improve their business performance. This research revealed that simply opening up to external knowledge and collaborating with external organizations is not enough to achieve positive effects. It is necessary to take advantage of the opportunities and advantages generated through open innovation, prioritizing innovative performance first. These findings translate into several results, such as increased total revenue and operating profit margin, increased sales volume, stronger position vis-à-vis competitors, higher profitability, growth rate, financial strength, and improved reputation in the marketplace.

When MSMEs achieve outstanding performance through effective management of open innovation activities, they can generate valuable and uncommon resources, which are difficult to imitate by other competing companies. Moreover, these resources imply a high cost of possession or implementation, which makes it difficult for competitors to imitate or substitute them. In this context, MSMEs in the fruit and vegetable sector can be organized in such a way as to generate a competitive advantage, i.e., differentiation from competitors and a superior market position. While the study shows that open innovation activities have a direct impact on the company's competitive advantage—with a B coefficient of 0.278—it is observed that, when applying the open innovation pathway reflected in the indirect effects, the B coefficient increases to 0.662, indicating an even more significant correlation.

The findings of this study provide relevant inputs for policymakers and MSME microentrepreneurs who wish to build and improve the open innovation system. Specifically, microentrepreneurs need to know that using internal and external ideas to promote their innovative capabilities will help them obtain better business results and a competitive advantage. This requires being entrepreneurial, innovative, proactive, risk-tolerant, and engaging in exploitation activities that allow them to open their knowledge frontiers and have more confidence in open innovation to discover and seek new collaborations that mitigate the lack of internal R&D resources.

An important reminder is that MSMEs cannot innovate individually. Open innovation is needed to survive in today's dynamic environment. Therefore, microentrepreneurs must concentrate on adapting strategies to the institutional environment.

Public policymakers in the agricultural sector should aim to consolidate the National Agricultural Innovation Systems and promote the fruit and vegetable industry to expand the export food basket, favoring farmers and guaranteeing food security to face future pandemics, such as coronavirus.

Limitations and future research

As a result of this analysis, some limitations have been discovered, simultaneously translating into opportunities for future explorations. The study was conducted in one department (a form of political-administrative division used in Colombia). The model can be replicated in other departments or political-administrative regions with a high potential for fruit and vegetable production in Colombia or other Latin American countries with similar characteristics. Comparative studies can also be carried out with other developing countries to understand better the behavior of open innovation in the fruit and vegetable sector in other cultures.

The effects of other variables such as learning, absorptive capacity, ambidexterity with open innovation, and the addition of other performance variables (business model, productivity, efficiency) can be measured to demonstrate the role of dynamic capability in achieving a sustainable competitive advantage. Cross-sectional data were analyzed, so longitudinal studies are suggested.

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