

Do Colombian food firms apply incoming open innovation?¹

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Abstract

Open innovation has garnered considerable attention from scholars over the last decade, particularly in low technology-intensive sectors, including the food business. This sector significantly influences the gross domestic product of developed and emerging nations and plays a crucial role in creating jobs. Our study used a quantitative structural equation method on 1,384 Colombian food enterprises. The findings suggest that employing the incoming open innovation strategy, enhanced by absorptive ability, promotes product innovation development in

food firms. Empirical evidence demonstrates that absorptive capacity partially mediates the link between incoming open innovation and product innovation. Food firms should enhance their engagement with customers, suppliers, competitors, colleges, and consultants to expand their knowledge base. They also improve their absorptive ability, enabling them to introduce solutions that meet customer needs in a more competitive landscape.

Keywords: Incoming open innovation, absorptive capacity, product innovation, food industry, Latin America.

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¿Aplican las empresas alimentarias colombianas la innovación abierta entrante?

Resumen

La innovación abierta ha suscitado un gran interés entre los académicos en la última década, especialmente en las industrias de baja intensidad tecnológica y en la industria alimentaria. Esta industria tiene un impacto relevante en el PIB de las economías desarrolladas y emergentes y su contribución esencial a la generación de empleo. Nuestra investigación aplica un enfoque cuantitativo de ecuaciones estructurales a 1.384 empresas alimentarias colombianas. Los resultados indican que la aplicación de la estrategia de innovación abierta entrante complementada

con la capacidad de absorción favorece el desarrollo de la innovación de producto en las empresas de alimentos. También se comprobó empíricamente que la capacidad de absorción media parcialmente la relación entre la innovación abierta entrante y la innovación de producto. Se concluye que las empresas alimentarias deberían estar más abiertas a interactuar con clientes, proveedores, competidores, universidades y consultores para ampliar su base de conocimientos. Además, desarrollan su capacidad de absorción, pudiendo así lanzar productos que satisfagan a sus clientes en un entorno más competitivo.

Palabras clave: innovación abierta entrante, capacidad de absorción, innovación de productos, industria alimentaria, América Latina.

¿As empresas colombianas do sector alimentar aplicam a inovação aberta de entrada?

Resumo

A inovação aberta tem gerado muito interesse por parte dos académicos na última década, especialmente em indústrias de baixa intensidade tecnológica e na indústria alimentar. Esta indústria tem um impacto relevante no produto interno bruto das economias desenvolvidas e emergentes e a sua contribuição essencial para a geração de emprego. A nossa investigação aplica uma abordagem quantitativa de equações estruturais a 1384 empresas colombianas do sector alimentar. Os resultados indicam que a aplicação da estratégia de inovação de entrada

aberta complementada pela capacidade de absorção favorece o desenvolvimento da inovação de produtos nas empresas do sector alimentar. Também foi comprovado empiricamente que a capacidade de absorção medeia parcialmente a relação entre a inovação aberta de entrada e a inovação de produto. Conclui-se que as empresas do sector alimentar devem estar mais abertas à interação com clientes, fornecedores, concorrentes, universidades e consultores para alargarem a sua base de conhecimentos. Além disso, desenvolvem a sua capacidade de absorção, sendo assim capazes de lançar produtos que satisfaçam os seus clientes num ambiente mais competitivo.

Palavras-chave: Inovação de entrada aberta, capacidade absorptiva, inovação de produto, indústria de alimentos, América Latina.

Introduction

Academics and business managers have shown a great interest in open innovation jobs (Obradović et al., 2021). Henry Chesbrough coined “open innovation” (Gao et al., 2020). According to Tang et al. (2021), open innovation has two modalities. First, the firm applies incoming open innovation, aiming to innovate through collaboration and searching for external knowledge. Simultaneously, the firm engages in outbound open innovation by selling other firms’ intellectual property, like patents or licenses.

On the other hand, policymakers focus their attention on food firms. They believe that food firms contribute to their economies (Khan et al., 2021). It is also important to note that innovation allows introducing innovative products to the market, making the firm sustainable over time. Moreover, to achieve this condition, firms implement the incoming open innovation strategy to obtain knowledge and collaboration from external agents such as suppliers, customers, competitors, and universities. Apply this strategy and the development of absorptive capacity, a dynamic capacity that allows firms to identify external knowledge and improves their innovation performance (Song et al., 2018).

It is also important to note that innovation allows firms to introduce innovative products to the market, making them sustainable over time. To achieve this condition, firms implement the incoming open innovation strategy to obtain knowledge and collaboration from external agents such as suppliers, customers, competitors, and universities.

When reviewing the literature on open innovation in developed economies, one will find topics linked to collaboration (Leckel et al., 2020), incoming and outbound open innovation (Tang et al., 2021), and

technological innovation (Hervas-Oliver et al., 2021) among others. Meanwhile, it is also important to point out that in Latin America, some studies related to the topic have been developed, such as Valdez-Juárez and Castillo-Vergara (2020), who analyze Mexican small and medium-sized enterprises, concluding that technological capacity influences the application of the open innovation approach. However, what has been done is still insufficient compared to the number of studies conducted in developed economies.

This study has presented the subsequent research inquiries: How do implementing an incoming open innovation strategy and cultivating absorptive ability augment product innovation in food firms? How does absorptive capacity interact with incoming open innovation and product innovation in food firms? A conceptual model was developed (refer to Figure 1) utilizing a quantitative structural equation methodology on a dataset of 1384 Colombian food enterprises involved in the 2019 innovation survey.

This research provides several theoretical contributions. The first refers to increasing the literature on open innovation in low technological intensity firms, especially food firms. The second one is related to shedding light on the role of absorptive capacity. The literature has pointed out that absorptive capacity determines dynamic capacity in the innovation processes carried out by food firms. The third refers to deepening knowledge of the relationship between the open innovation paradigm and absorptive capacity. Some authors, such as Bhadauria and Singh (2022), consider that absorptive capacity frequently appears in articles on open innovation, specifying that the relationship between open innovation and absorptive capacity needs to be better studied. However, it is established that firms that develop this relationship improve their innovation capacity.

This study has the following structure: first, the theoretical framework and the formulation of the hypotheses; second, the methodology; third, the results; and finally, the discussion, conclusions, limitations, and future lines of research.

Theoretical framework and formulation of hypotheses

Recently, researchers have shown a particular interest in open innovation. In this way, authors like Radicic and Alkaraan (2022) have defined this term as the strategy firms implement to identify useful external sources of knowledge to enhance customer satisfaction by creating and capturing value. It is said that the collaboration between agents belonging to the innovation system facilitates the way to obtain external knowledge, so this research is based on this resource-based view. So, the firm can absorb, transform, and make innovation progress due to external knowledge (Audretsch and Belitski, 2023).

Incoming open innovation and product innovation

There has been a certain amount of research about the association between product innovation and incoming open innovation based on the point of view of food industry firms. For example, Audretsch and Belitski (2023) point out that beverage and food firms perceive the open innovation paradigm: looking for a synergy process with their customers, suppliers, and competitors in their supply chain. This kind of innovation has become very useful in an increasingly competitive industry. Moreover, Flor et al. (2019) emphasize that firms with no remarkable inversion in research and development are at a clear technological disadvantage. So, they put open innovation strategies into practice to develop innovations.

In that sense, Ebersberger et al. (2021) have examined several studies on the link between firms' innovation performance and incoming open innovation, resulting in the finding that firms seek collaborations to acquire knowledge as well as to expand and manage product innovation development with the necessary absorptive capacity. Furthermore, Obradović et al. (2021) demonstrated that most firms willing to implement open innovation strategies are those with high technological intensity. Nonetheless, low technological intensity firms are more likely to adopt open innovation due to environmental changes because they allow them to reduce costs and improve the development of new products.

Additionally, Bigliardi et al. (2020) state that a gap still needs to be explained to understand how open firms can harness innovation to achieve innovative results. According to some authors, it might be possible with absorptive capacity, yet other authors have acknowledged the immensity of ways to implement it, making the results of current investigations inconclusive. In that sense, the following hypothesis is proposed:

Hypothesis 1: Incoming open innovation has a significant effect on product innovation.

Incoming open innovation and absorptive capacity. It is a fact that food firms increase their interaction with the most significant possible number of members in their supply chain; Lowik et al. (2017) identified that firms can obtain new knowledge if they develop relationships with suppliers, customers, and universities. This also helps firms to improve their employees' absorptive capacity. Since knowledge is a valuable resource for food firms, they seek to enhance their absorptive capacity to identify and adapt external knowledge, enabling them to develop innovations (Strøm-Andersen, 2020; Mirza et al., 2022). So, firms must apply the incoming open innovation strategy if they want

access to a more significant number of sources of knowledge and achieve the best results.

In addition, Bhadauria and Singh (2022) noted that improving innovation capacity is another reason food firms implement an open innovation strategy and optimize their absorptive capacity. In that sense, food firms are more likely to develop product innovations and to study and use new knowledge to establish collaborations quickly. According to Cuevas-Vargas et al. (2022), firms enhance their internal organization capacities, with absorptive capacity being the most accurate for exploring and exploiting external knowledge, which allows them to strengthen their innovation capacity. Besides, low-tech firms tend to optimize their absorptive capacity via innovation activities. Subsequently, the following hypothesis is proposed:

Hypothesis 2: Incoming open innovation has a significant effect on absorptive capacity.

Absorptive capacity and product innovation. Various studies have acknowledged the benefits of absorptive capacity, especially in product innovations. Pihlajamaa (2021) identified that developing a firm's absorptive capacity successfully implements the incoming open innovation strategy. It mainly enhances the firm's capacity to analyze its environment and identify relevant knowledge to develop innovation through assimilation. Moreover, Saiz et al. (2018) found that absorptive capacity optimizes firm innovation performance because it directly relates to external sources of knowledge.

Furthermore, Kobarg et al. (2020) pointed out that firms can improve innovation development through collaboration agreements because they allow them to obtain external knowledge and enhance their absorptive capacity. However, Ramayah et al. (2020) focused on the relationship between firms' innovation performance and absorptive

capacity. Their work indicates that having access to sources of knowledge and developing absorptive capacity allows firms to enforce their innovation capacity. Also, firms can build their capacity to innovate by exploiting external knowledge. In that sense, Yang et al. (2022) stated that accurate responsiveness to market demands is an excellent way to develop product innovation. The firm can also achieve it when there is an actual understanding of customers' needs and access to external knowledge. It is hypothesized.

Hypothesis 3: Absorptive capacity has a significant effect on product innovation.

Absorptive capacity mediates between incoming open innovation and product innovation. There have been several studies focused on absorptive capacity as a mediator. For example, Xin et al. (2020) investigate how obtaining access to various sources of knowledge and a broad technological knowledge base is possible through absorptive capacity. Also, Ramayah et al. (2020) mentioned that the efficiency of innovation activities can be improved with absorptive capacity, which enforces the launching of new products.

Since absorptive capacity can be depicted as a helpful dynamic capacity for firms, Ortiz et al. (2021) state that developing the skills to recognize new business opportunities and assimilating them with their technological resources will upgrade the firm's position to develop product innovations. In that sense, the absorptive capacity plays a mediating role between product innovations and the sources of knowledge. According to Al-Hakimi et al. (2021), firms with high absorptive capacity are more likely to get used to environmental changes, resulting in a better position to exploit external knowledge effectively and develop innovations.

However, Rehman et al. (2021) comment that the theory of organizational learning, as

well as the theory of dynamic capabilities, are useful analytical tools to study absorptive capacity, which is an essential ability to improve results in innovation. Moreover, Wang and Wang (2022) denote that the relationship between technological innovation and sources of knowledge can also be enhanced with absorptive capacity. Hence, it is fundamental for food firms that have already developed technological innovations to enforce their absorptive capacity because it improves their ability to identify and effectively use external knowledge. Consequently, the subsequent hypothesis is presented as follows:

Hypothesis 4: Absorptive capacity behaves as a mediator between incoming open innovation and product innovation.

Firm size as a moderator among absorptive capacity and incoming open innovation. Medase (2020) has widely considered the analysis of firm size as a moderator, pointing out that large firms have more resources and knowledge to develop innovations. However, while other authors show that the results are diverse and that small firms need more financial resources for research and development, it is also true that small firms are more flexible and adapt more quickly to environmental changes (Bachmann et al., 2021).

According to Medase (2020), the moderating role of firm size has been widely studied; more specifically, this author mentions that large firms are better positioned to develop innovation due to their vast resources and knowledge. Nonetheless, small firms count on the necessary flexibility to adapt quickly to environmental changes. However, other authors consider that these firms require higher financial resources to develop research and development, so the results are, in fact, diverse (Bachmann et al., 2021).

Another feature analyzed is the development of capacities to benefit from the knowledge base of the most prominent firms. In this context, it is easier for their employees to exploit the knowledge and transform it into innovations (Petruzzelli et al., 2018). Likewise, small firms count on many creative employees who can exploit said ability to develop innovations. Also, Yu and Lee (2017) note that large firms can simplify the process of creating innovation projects because of their human and financial resources. In that way, the following hypotheses are proposed:

Hypothesis 5a: Firm size moderates the relationship between incoming open innovation and product innovation.

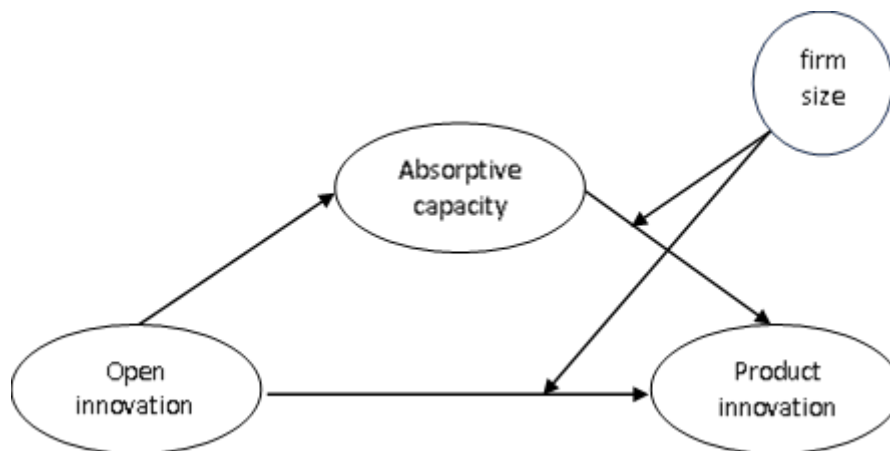
Hypothesis 5b: Firm size moderates the relationship between absorptive capacity and product innovation.

Methodology

Data. This study focuses its attention on Colombian food firms. Those food firms participated in the Colombia Innovation Survey (Departamento Administrativo Nacional de Estadística, 2019). A sample of 1,384 food firms was selected; they are food firms belonging to the processing and preservation of meat and fish (ISIC 101), processing and preservation of fruits, vegetables, and tubers (ISIC 102), processing of oils and fats (ISIC 103), processing of dairy products (ISIC 104), processing of mill products, starches and their derivatives (ISIC 105), processing of coffee products (ISIC 106), processing of sugar and panela (ISIC 107), processing of other food products (ISIC 108), processing of prepared animal feeds (ISIC 109), and processing of beverages (ISIC 110). **Figure 1** shows the theoretical model of this research

Figure 1.

Theoretical model



Source. Own elaboration

Variables. Product innovation is a dependent and continuous variable, defined as follows: the firm introduced an innovation in a good or service. It was obtained by applying factor analysis of two items: (1) PI1: total innovations 2017-2018 in new goods or services only for your firm (already existing in the national and international market) and (2) PI2: total innovations 2017 -2018 in significantly improved goods or services for your firm (already existing in the national and international market).

The independent variables are incoming open innovation and absorptive capacity. Incoming open innovation is measured following Gentile-Lüdecke et al. (2020), who considered dichotomous items (1 = yes, 0 = no) from the following sources of knowledge: (1) IOI1: consultants, experts, or researchers, (2) IOI2: universities, (3) IOI3: public institutions (ministries, decentralized entities, secretariats), (4) IOI4: fairs and exhibitions, (5) IOI5: books, magazines or catalogs, (6) IOI6: industry associations, (7) IOI7: customers, and (8) IOI8: suppliers.

In the absorptive capacity, the following items are found: (1) ACAP1: internal development of research and development (R&D), (2) ACAP2: training activities for innovation, and (3) ACAP3: presents a research department in development and innovation, according to Liu et al. (2021). These items are dichotomous, indicating 1 = if implemented and 0 = if not implemented.

The control variables include firm size and machinery acquisition. These factors may impact how innovative products are realized. Firm size (expressed in logarithm) is measured by the number of employees, according to Medase (2020). Moreover, machinery acquisition is measured by the ratio of expenditure on machinery and equipment acquisition among the total average sales (Wadho and Chaudhry, 2018).

Method of analysis. A two-step structural equation model (SEM) was conducted using AMOS version 23. Before applying the SEM approach, the reliability and validity of the data were verified through factor analysis.

Then, the measurement model was obtained using confirmatory factor analysis (CFA) using SPSS version 25. Second, the structural model was estimated, where the relationships among the constructs were obtained using the coefficients and the level of statistical significance. Third, the moderation and mediation analysis were conducted using PROCESS (A macro-SPSS)

Results and Discussion

Results

This investigation’s findings are delineated in seven phases: Initially, descriptive statistics; subsequently, the outcomes of factor analysis; thirdly, the findings of the measurement model; fourthly, the results of the structural model; fifthly, mediation analysis; lastly, moderation analysis; and seventhly, control variables.

The independent variables of product innovation, incoming open innovation, and absorptive capacity were analyzed using exploratory factor analysis. Factor loadings were found to be greater than 0.5 (Cabrera et al., 2008). The Kaiser-Meyer-Olkin index (KMO) was more significant than 0.5, and the Bartlett sphericity value showed a significance level (p-value) greater than 0.05. Table 2 shows each independent variable’s factor loadings and goodness of fit. According to Jiménez et. al., 2016, the percentage of total variance explained shows the following results: product innovation (61.00%), incoming open innovation (49.14%), and absorptive capacity (62.72%).

Descriptive statistics. Table 1 shows the descriptive statistics of Colombian food firms. They have been classified according to their size into small, medium, and large. For this purpose, the average employed personnel (full-time, permanent, and temporary) in 2018 is considered.

Table 1.

Number of firms by size

Firm size	Quantity
Small (≤50 employees)	697
Medium (51 to 250 employees)	484
Large (≥251 employees)	203
Total	1384

Source. Own elaboration, using SPSS v. 25

Factor analysis. The independent variables of product innovation, incoming open innovation, and absorptive capacity were analyzed using exploratory factor analysis. Factor loadings were found to be greater than 0.5 (Arias González y Muñoz Durán, 2021). The Kaiser-Meyer-Olkin index (KMO) was more significant than 0.5, and the Bartlett sphericity value showed a significance level (p-value) greater than 0.05. Table 2 shows each independent variable’s factor loadings and goodness of fit. According to Hernández and Gutiérrez (2016), the percentage of total variance explained shows the following results: product innovation (61.00%), incoming open innovation (49.14%), and absorptive capacity (62.72%).

Table 2.

Factor loadings of variables for food firms

Variable	Indicator	Factor loadings	Goodness of fit
Product innovation	PI1	0.781	KMO: 0.500 Barlett: 68.539 (p=0.001)
	PI2	0.781	
Incoming open innovation	IOI1	0.700	KMO: 0.873 Barlett: 3910.39 (p=0.001)
	IOI2	0.690	
	IOI3	0.592	
	IOI4	0.800	
	IOI5	0.800	
	IOI6	0.570	
	IOI7	0.714	
	IOI8	0.742	
Absorptive capacity	AC1	0.850	KMO: 0.626 Barlett: 841.34 (p=0.001)
	AC2	0.834	
	AC3	0.681	

Source. Own elaboration, using SPSS v. 25

Measurement model. Reliability indicators, convergent validity, multicollinearity analysis, and coefficient of determination were calculated to evaluate the measurement model. **Table 3** shows that most indicators meet the minimum standards. In the case of internal reliability, this study assumes

that the composite reliability index is more reliable than Cronbach’s alpha. In the case of extracting the average variance, the values obtained are more significant than 0.5, and the variance inflation factor measuring multicollinearity is less than 2.

Table 3.

Indicators of reliability and validity of food firms

Latent variable	CA	CR	AVE	VIF	
Product innovation	0.324	0.758	0.610	0.824	
Incoming open innovation	0.844	0.884	0.500	1.580	
Absorptive capacity	0.683	0.833	0.627	1.580	0.512
Reference values	>0.7	>0.7	>0.5	<5	

CA, Cronbach’s Alpha; CR, composite reliability; AVE, average extracted variance; VIF, variance inflation factor.

Source. Own elaboration, using SPSS v. 25

This study assessed discriminant validity by applying Rönkkö and Cho’s (2022) criteria. As **Table 4** shows, the square root of the variance extracted (AVE) (diagonal and bold) should

be larger than the correlation coefficient between the variables. The results show that the model meets this requirement.

Table 4.

Discriminant validity of food firms

	Product innovation	Incoming open innovation	Absorptive capacity
Product innovation	0.781	-	-
Incoming open innovation	0.450	0.706	-
Absorptive capacity	0.490	0.632	0.792

Source. Own elaboration, using SPSS v. 25

Structural model. The following indicators were calculated to evaluate the quality of the model: the chi-square value was 362.802, the comparative fit index was 0.955, the root mean square error of approximation was 0.051, and the significance level of the coefficient was less than 0.01, as

shown in **Table 5**. The results show that absorptive capacity and open innovation have a significant positive relationship with product innovation. Furthermore, a statistically significant positive relationship exists between incoming open innovation and product innovation.

Table 5.

Results of the structural model

Hypothesis	Coefficient	P-value
H1: IOI→AC	0.716***	0.001
H2: AC→PI	0.500***	0.001
H3: IOI→PI	0.419***	0.001

IOI: Incoming Open Innovation; AC: Absorptive Capacity; PI: Product Innovation. P-value: *p<0.1; **p<0.05; ***p<0.001.

Source. Own elaboration, using AMOS v. 23

The values obtained show an adequate goodness-of-fit for the theoretical. Therefore, in this sense, the structural model shows a good fit (Shi et al., 2019) (See **Table 6**).

Table 6.

Goodness-of-fit index

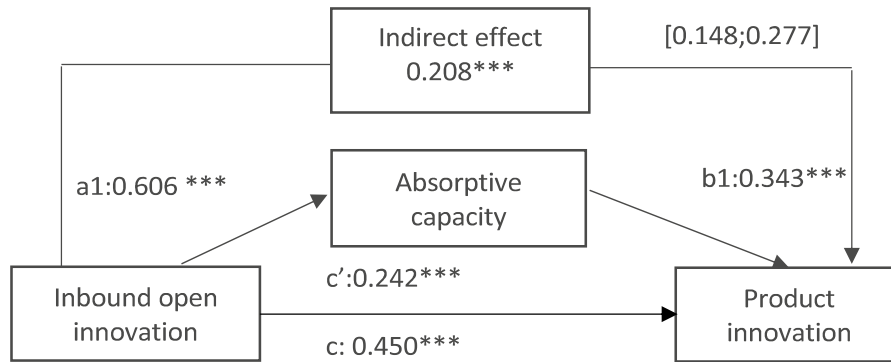
Indexes	Structural model	Acceptable adjustment level
CMIN/DF	4.651	<1;5>
NFI	0.944	0.90 a 1
CFI	0.955	0.95 a 1
RFI	0.925	0.90 a 1
IFI	0.956	0.95 a 1
RMSEA	0.051	<0.08

Source. Own elaboration.

Mediation analysis. When conducting mediation analysis according to the standards of Igartua and Hayes (2021), the relationship exhibits a partial mediation relationship when the direct and indirect coefficients are significant.

According to *Figure 2*, absorptive capacity partially mediates the relationship between open innovation and product innovation. Furthermore, applying PROCESS analysis confirmed that the association is significant since the confidence interval does not include zero (Cabeza-Pullés et al., 2020).

Figure 2.
Mediation analysis



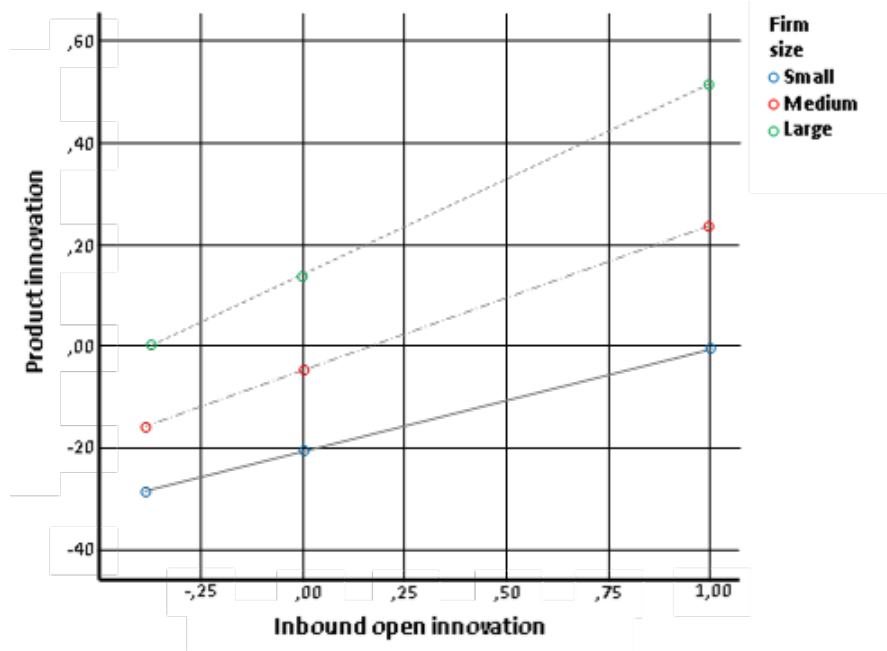
P-value: *p<=0.1; **p<=0.05; ***p<=0.001.

Source. Process software, version 3

Moderation Analysis. Moderation analyses were performed using PROCESS. Firm size is considered a moderator. The study was conducted following the guidelines of Menon et al. (2018). Calculating the coefficient, the results show that enterprise size moderates the relationship between open innovation and product innovation, with a coefficient of 0.142 and a p-value of 0.001, which is lower than the significance level of 0.05. **Figure 3** shows a direct positive relationship between firm size at three levels (small, medium, and large) and open innovation and product innovation, with coefficients of 0.199, 0.285, and 0.371, respectively, and p-values of 0.001, 0.001, and 0.001. or any size firm.

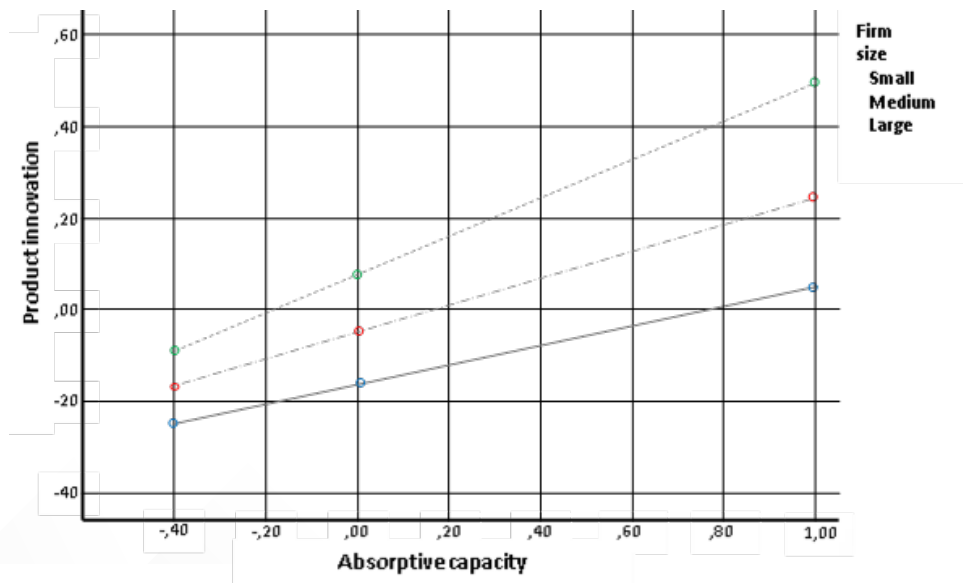
The results show that enterprise size moderates the relationship between absorptive capacity and product innovation, with a coefficient of 0.181 and a p-value of 0.001, which is lower than the significance level of 0.05. **Figure 4** shows a direct positive correlation between absorptive capacity and product innovation at the three levels of enterprise size: small, medium, and large. The coefficients are 0.206, 0.316, and 0.426, respectively, and the significance levels are 0.001, 0.001, and 0.001. It is suitable for firms of all sizes.

Figure 3.
Moderation graph



Source. Own elaboration using Process software, version 3

Figure 4.
Moderation graph



Source. Own elaboration using Process software, version 3.

Control variables. When the control variables are analyzed (See **Table 7**), the firm size variable has a positive and statistically significant relationship. Moreover, the

machinery acquisition variable has a negative relationship and is not statistically significant.

Table 7.

Coefficients for control variables

Control variable	Coefficient	P-value
Firm size	0.122**	0.005
Acquisition of machinery	-0.020	0.605

*p<=0.1; **p<=0.05; ***p<=0.001.

Source. Own elaboration.

Discussion

This study examines the correlation between adopting open innovation and enhancing absorptive capacity in Colombian food firms to augment product innovation capability. The findings indicate that this association is both favorable and statistically significant.

Colombian food firms implement the incoming open innovation strategy, seeking to collaborate with clients, suppliers, competitors, universities, and laboratories to access sources of knowledge, which will allow them to improve their capacity for product innovations. The findings corroborate hypothesis 1 (p-value < 0.001), demonstrating that incoming open innovation substantially influences product innovation. These results are similar to those obtained by Lee and Yoo (2019).

Furthermore, Colombian food firms implementing the incoming open innovation strategy simultaneously develop their absorption capacity. This dynamic capacity helps them identify, assimilate, and exploit

knowledge to develop product innovations and achieve long-term sustainability. The results support hypothesis 2 (p-value < 0.001), which indicates that incoming open innovation is positively related to absorptive capacity. Studies conducted by These Lowik et al. (2017) and Wang and Wang (2022) show that they have obtained similar results.

Empirical evidence shows that absorption capacity positively and significantly impacts product innovation. The results obtained support Hypothesis 3 (p-value < 0.001), specifying that Lowik et al. (2017) presented similar results.

The findings suggest that absorptive capacity partially mediates the connection between incoming open innovation strategy and product innovation. Moreover, alongside the execution of the forthcoming open innovation approach, it is imperative to cultivate product innovation to enhance businesses' absorptive ability, thereby augmenting their capacity for product innovation. These findings correspond with those reported by Lowik et al. (2017) and Wang and Wang (2022).

According to Zou et al. (2018), the relationship between absorptive capacity and firm size has presented mixed results. However, this research shows that firm size moderates the relationship between absorption capacity and product innovation. At the same time, Jugend et al. (2018) specify that the firm size influences the application of the open innovation strategy. This finding aligns with the study, as firm size influences the relationship between incoming open innovation and product innovation.

When analyzing the control variables, it was found that the only significant variable is the firm size (p -value <0.001). That is to say that larger firms manage a large variety of resources. Moreover, for this reason, they perform several innovation activities, developing their innovation capacity (Bayona-Saez et al., 2017).

Conclusions, Limitations, and Future Research

The results of the study indicate that the implementation of an open innovation strategy and the enhancement of absorptive capacity improve the product innovation capabilities of food firms. The study demonstrates a positive correlation between absorptive capacity and incoming open innovation. This research illustrates the mediating function of absorptive capacity in the connection between incoming open innovation and product innovation. Firms must seek external sources and collaborations to expand their boundaries and improve their absorptive capacity. Firm size moderates two critical relationships: the first between incoming open innovation and product innovation and the second between absorptive capacity and product innovation.

Theoretical Implications. This study adds to what is known about open innovation in the food

business. First, it adds to the body of research on open innovation in low-tech companies since most studies have been done on high-tech companies (Secundo et al., 2019). It shows that Colombian food firms value connecting with universities, technology fairs, suppliers, and customers.

Second, the literature has pointed out that absorptive capacity is a dynamic capacity that is a determining factor in the innovation processes carried out by food firms. Absorptive capacity favors product innovations, but the various studies differ, especially in how absorptive capacity is measured and the methodological approach used. Most studies apply logistic models. Our contribution is the application of structural equation modeling. For example, the research by Audretsch and Belitski (2023) applies Logit and Tobit model, while Lowik et al. (2017) and Wang and Wang (2022) use the partial least square model.

Third, this study shed light on the relationship between the open innovation paradigm and absorptive capacity. According to Bhadauria and Singh (2022), some researchers overlap both concepts; however, it is established that firms that develop this relationship improve their innovation capacity. This study analyzes this relationship in an industry of low technological intensity, which develops activities in an emerging economy.

Fourth, this study has proved that the firm size behaves as a moderator; in other words, large firms have more resources to develop their product innovation capacity.

Managerial and Policy Implications. Managers of low technology-intensive manufacturing firms needing more financial resources to conduct research and development activities should apply the incoming innovation strategy. In this way, firms can access diverse sources of knowledge and collaboration, such as suppliers, customers,

consultants, and universities. Firms should not limit themselves to internal sources but implement the incoming open innovation strategy. In this way, they can expand their knowledge base and, with their absorptive capacity, improve their capacity for product innovation. As a result, firms introducing new products will have satisfied customers and be sustainable over time.

On the other hand, the results obtained can help policymakers promote innovation. Encouraging the members of the national innovation system to interact, exchange knowledge, and seek collaboration meetings can help identify market needs for new products. It is also suggested that innovation promotion policies be designed to encourage firms to invest in research and development and train their employees to develop their absorptive capacity.

Limitations and Future Research. This research has limitations. The first one is the cross-sectional nature of its methodology, which limits possible cause-and-effect relationships. According to the theory examined, there is a connection between absorptive capability, product innovation, and the implementation of the incoming open innovation approach in the present study. A different sector, like the garment industry,

would be an excellent place to conduct longitudinal studies in the future.

The second one is related to the use of the database of the National Statistics Office of Colombia; the answers obtained correspond to a questionnaire based on the Bogotá Manual, which was elaborated by taking the Oslo Manual as a reference. The development of a questionnaire would allow for better measurement of the variables. In this sense, it is suggested that El Maalouf and Bahemia (2022), who propose a diversity of activities from a dynamic capabilities perspective, should be considered when measuring the incoming open innovation variable. Meanwhile, consider (Ahmed et al., 2020) for measuring absorptive capacity.

While it is true that this research contributes to the literature on the application of the open innovation approach, there are still lines of future research, such as those pointed out by Bhadauria and Singh (2022), who suggest paying more attention to investigating food SMEs, since these firms have few resources to carry out research and development projects, and must make up for this limitation to identify other methods to develop their absorptive capacity. It should be noted that the analysis of the firm size variable indicated that the larger the firm, the more prone it is to product innovation.

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