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Impact of innovation strategy, absorptive capacity, and open innovation on SME performance: A Chilean case study

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ABSTRACT

Open innovation has an important impact on the innovative activity and competitiveness of SMEs. Moreover, it is a topic of interest for academics and practitioners. This study analyzes, in the context of SMEs, how absorptive capacity can favor incoming and outgoing open innovation practices, the mediating role that innovation strategy plays in this relationship, and the effect of open innovation practices on performance. Partial least squares (PLS-SEM) and empirical data obtained from interviews with 194 managers of Chilean manufacturing SMEs with between 10 and 250 employees were used. The results obtained make a relevant contribution to the literature in two aspects: (1) absorptive capacity has a significant and positive influence on firms' strategies and outbound innovation practices and (2) firm strategies play a complete mediating role between absorptive capacity and inbound open innovation practices and a complementary mediating role between absorptive capacity and outbound open innovation practices. Additionally, the results show that open innvoation improves SME performance. These results have important theoretical and practical implications for both policy makers and SME managers.

1. Introduction

Open innovation has an important impact on innovative activity in SMEs, and can be a driving force for national and regional economic growth (Tsai et al., 2022). In addition, it is a topic of great interest to academics and practitioners. Open innovation is a strategy for companies to innovate by exploiting their own knowledge and exploring the knowledge of their environment (Chesbrough, 2006a).

Rapid technological change has radically transformed the way companies innovate and has demonstrated the need in knowledge markets to collaborate and co-create (Sengupta and Sena, 2020). OI has had a relevant impact on innovative practices, increasing business performance and innovation through incoming and outgoing flows of knowledge (Radziwon and Bogers, 2019; Leckel et al., 2020; Rogo et al., 2014; Avalos-Quispe and Hernández-Simón, 2019; Molina Sánchez et al., 2022). For SMEs, the OI model can be a way of overcoming their resource and capacity limitations and promoting the development of new products (Kapetaniou and Lee, 2018) to face the challenges of a dynamic market (Hung et al., 2011). However, the open innovation efforts of small and medium-sized businesses must be long-term in nature if they are to be successful (Radziwon and Bogers, 2019) and thus increase their competitive advantages over their rivals (Singh et al., 2019; Yun et al., 2022).

There is a wealth of empirical research regarding the causes of OI (Stanisławski, 2020). However, few studies have analyzed their impact on open innovation activities. Successful open innovation requires that the SME has the necessary capabilities to carry out these activities and that they are integrated into the framework of the company's innovation strategy. A critical determinant of OI is a company's absorptive capacity (Jasimuddin and Naqshbandi, 2019). Combining internal information exchanges with fresh external sources of knowledge, absorptive capacity encourages innovation (Ritala and

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Hurmelinna-Laukkanen, 2013). Absorptive capacity is a dynamic key to successful OI in SMEs (Yun et al., 2018; Idrissi and Castonguay, 2019), and it boosts business performance, contributing to improving company competitiveness (De Zubielqui et al., 2016). Absorptive capacity is a key element in a company's innovation strategy design (Müller et al., 2020). The combination of absorptive capacity and innovation strategy reinforces open innovation activities (Barham et al., 2020).

The objective of this study is to analyze how absorptive capacity and innovation strategy might improve open innovation activities and how this impacts the performance of small and medium-sized enterprises. The mediating effects of strategy on absorptive capacity and open innovation practices are also studied. This study used a sample of sample of 194 Chilean SMEs from the manufacturing sector was used. The research questions are: Do the absorptive capacity and innovation strategies of SMEs favor open innovation practices? Does innovation strategy mediate the connection between absorptive capacity and open innovation practices? Do inbound and outbound open innovation practices improve SME performance? Answering these research questions is essential. First of all, the association between absorptive ability and OI in SMEs has been lightly studied, and additional research is required (Idrissi and Castonguay, 2019). This study fills these gaps in the literature. Second, knowledge about open innovation in big companies cannot easily be applied to SMEs (Vanhaverbeke et al., 2018). These companies need a specific framework that can help them become successful in developing open innovation practices (Radziwon and Bogers, 2019).

There are numerous ways in which this research adds to the body of knowledge. Firstly, we look at how innovation strategy affects the relationship between absorptive ability and open innovation practices from a theoretical perspective. Our results confirm total mediation on inbound open innovation practices. All the effects of absorptive capacity on inbound open innovation practices are explained by companies' innovation strategies. However, in outbound activities, this mediation is complementary. Companies' innovation strategy can only partially explain the effects of absorptive capacity on open innovation practices. Second, from the empirical perspective, our study is focused on SMEs in the context of an emerging country, Chile. The majority of the existing studies on open innovation have centered on developed countries (Vrgovic et al., 2015; De Paulo et al., 2017; Pérez et al., 2019). SMEs located in emerging countries have difficulties participating in inter-business activities (Sengupta and Sena, 2020; Gentile-Lüdecke et al., 2020). Managers can benefit from this research by learning how to implement open innovation.

The remainder of our study is structured as follows. First, we, we review the literature and present our hypotheses. In second place, we describe the research methodology and in third place we analyze the results. Finally, we discuss the results and present the conclusions, limitations and future lines of research derived from this study.

2. Literature review and hypotheses

OI is defined as "a distributed innovation process based on intentionally managed knowledge flows across organizational boundaries" (Chesbrough and Bogers, 2014), and can occur in the acquisition of technology or knowledge, as of use of social networks and cooperation (Harel et al., 2019). Then firms use internal as well as external ideas to achieve their innovation (Cricelli et al., 2021). OI involves performing internal activities such as generating new business with internal knowledge, involving employees who are not directly involved in the R&D process, as well as considering exploiting external ideas from customers, suppliers, universities and research centers (Van de Vrande et al., 2009), therefore, OI involves several business areas (Chesbrough, 2006b).

The literature review is carried out considering the theoretical concepts in Figure 1, where absorptive capacity, innovation strategy and inbound and outbound open innovation practices are found as axes. This review seeks to provide answers to the research questions posed. The following figure shows the theoretical model proposed in the research:

2.1. Absorptive capacity and open innovation

The absorptive capacity of a corporation is its ability to capture the value of new, external knowledge, integrate it, and apply it to economic objectives (Zahra and George, 2002). This capability enables businesses to survey their surroundings for new technologies and use external knowledge into their innovation processes (Ahn et al., 2016). For this reason, in terms of the connection between outside knowledge and innovative ideas, absorptive aptitude is an extremely important factor (De Zubielqui et al., 2016). It is a prerequisite to successful open innovation (Idrissi and Castonguay, 2019; Fertő et al., 2016). Absorptive capacity is necessary to develop successful inbound practices since it facilitates internalizing, taking advantage of, and using the knowledge acquired from outside (Huang et al., 2015; Lu et al., 2020a; Spithoven et al., 2010). Moreover, absorptive capacity can help companies improve their performance in strategic areas, such as creating new businesses and patents (Avalos-Quispe and Hernández-Simón, 2019), thereby enhancing the results of outbound open innovation (Naqshbandi and Tabche, 2018). We suggest the following hypothesis in light of these arguments:

H1. The relationship between absorptive capacity and inbound open innovation approaches is positive.

H2. The relationship between absorptive capacity and outbound open innovation approaches is positive.

2.2. Absorptive capacity and innovation strategy

Absorptive capacity promotes strategies for companies to acquire and assimilate external knowledge during innovation (Kim et al., 2018). It reinforces key functional areas in a company (Yeoh, 2009; Akram et al., 2020) and is essential to transform external knowledge into innovations (Saebi and Foss, 2015). In addition, it allows companies to explore new business opportunities (Filipe and Moutinho, 2016) and strategies to differentiate themselves and establish their reputations (Delmas et al., 2011). Absorptive capacity includes four dimensions: acquisition, assimilation, transformation, and exploitation (Zahra and George, 2002; Jiménez-Barrionuevo et al., 2011). Transformation is the capacity to integrate prior knowledge with newly learned information and knowledge that has been assimilated (Arias-Pérez et al., 2020). This transformative learning plays a fundamental role in innovation strategies (Jansen et al., 2006; Gebauer et al., 2012) because the acquisition of external knowledge shapes these strategies (Müller et al., 2020; Kranz et al., 2016). Companies that acquire, assimilate, modify, and utilise external knowledge are better equipped to use innovation tactics and subsequently seek out new business models (Müller et al., 2020). It is therefore possible to postulate that there is a positive association between absorptive capacity and innovation strategy (Díaz-Díaz and de Saá Pérez, 2014), leading to the following hypothesis:

H3. Absorptive capacity is correlated positively with innovative strategy.

2.3. Innovation strategy and open innovation

Strategies offer vision and objectives to companies (de Jager et al., 2004). They define the distribution of company activities and how they are interrelated (Porter, 1991; Lanzolla and Markides, 2021). Strategies based on adequate resource management and focused on resources and capabilities give companies a competitive advantage (Grant, 1991; Teece, 2007; Ong et al., 2010; Gamage et al., 2020). Innovation strategy

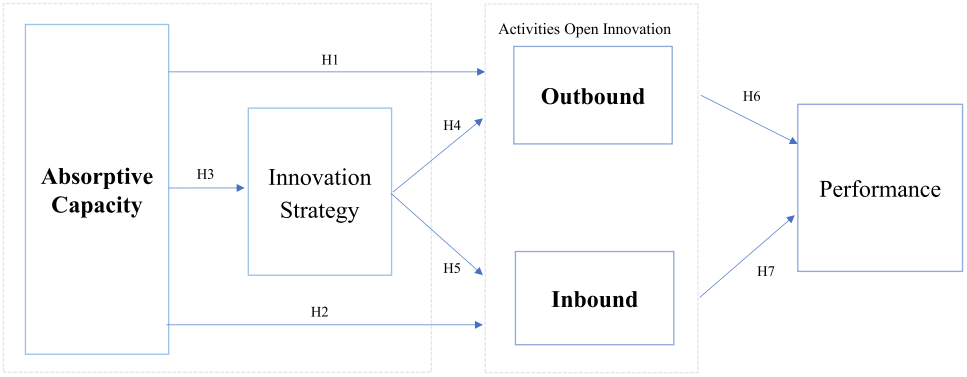

Fig. 1. Conceptual framework.
Source: Authors' design.

should form a part of a company's general strategy and should be incorporated in SMEs (Kennedy et al., 2017). Innovation strategy is key to the commercialization of innovations (Afuah, 2002; Tschirky et al., 2003; Fernandes et al., 2017). If it is well-defined, it opens the door to new technological possibilities and new market opportunities (Brunswicker and Vanhaverbeke, 2015).

OI should always be related to a company's strategy (Barham et al., 2020; Lichtenthaler, 2011; Vanhaverbeke and Cloodt, 2014). In the case of SMEs, this would facilitate a change in their business model, favoring performance (Odriozola-Fernández and Berbegal-Mirabent, 2020; Ramírez-Montoya et al., 2022). OI is an important innovation strategy that can significantly boost a company's competitive edge (Kraus et al., 2020). Opening innovation processes should be a part of a company's general strategy (Walecka-Jankowska and Zimmer, 2019). Innovation strategy favors companies' becoming more open to their surroundings (Crema et al., 2014) and implies investing more in technical abilities, resulting in better development of open innovation practices (Verbano et al., 2015).

Developing open innovation in a company is closely related to the capacity to absorb external innovations and to company strategy and management processes (Barham et al., 2020). Therefore, innovation strategy can mediate between absorptive capacity and open innovation practices. When it comes to gaining access to creative ideas and technologies, strategy becomes the focus point (Pollok et al., 2019). Thus, we propose the following hypotheses:

H4. The relationship between absorptive capacity and outbound open innovation practices is positively mediated by SMEs' innovation strategies.

H5. The relationship between absorptive capacity and inbound open innovation practices is positively mediated by SMEs' innovation strategies.

2.4. From open innovation to innovative performance

There is substantial evidence that open innovation has a positive effect on several firm performance metrics (Kraus et al., 2020; Hossain and Kauranen, 2016; Torres de Oliveira et al., 2020). Open Innovation provides multiple benefits that impact performance in SMEs (Torchia and Calabrò, 2019; Parida et al., 2012).

OI assists SMEs in gaining access to fresh ideas and information outside of their traditional bounds, lowering investment costs, and sharing risk (Sengupta and Sena, 2020). OI is widely acknowledged as a crucial tool for fostering creative thinking and new ideas (Radziwon and Bogers, 2019). OI activities help companies improve their technological standing, enter new markets (Popa et al., 2017; Yun et al., 2016), and launch their innovations more quickly (Albats et al., 2020; Alvarez-Meaza et al., 2020). This means that OI helps improve innovation performance and productivity (Greco et al., 2021; Lyu et al., 2020; Liu et al., 2022). To sum up, open innovation raises the likelihood of organizations coming up with ground-breaking new ideas, which in turn boosts the likelihood of business expansion (Sengupta and Sena, 2020; Wu and Zhou, 2021).

Therefore, we propose the following hypotheses:

H6. Outbound open innovation practices positively impact innovation performance in SMEs.

H7. Inbound open innovation practices positively impact innovation performance in SMEs.

The hypotheses posed in this study are shown in Figure 2. We consider the endogenous latent variables (dependent variables) and the exogenous variable (independent variable). The exogenous variable is absorptive capacity, and the endogenous latent variables are innovation strategy, inbound open innovation practices, outbound open innovation practices, and performance.

3. Research methodology

In this research a questionnaire was elaborated containing different items related to absorptive capacity, OI, innovation strategies and performance. The methodological design is quantitative and explanatory, focused on manufacturing SMEs in the metropolitan region. Having established the objectives of the research, the sample structure is presented, the selection of variables to obtain information on the different aspects analyzed is justified and, finally, the choice of the statistical technique used to analyze the research hypotheses raised in this research is explained.

3.1. Sample design and data collection

The survey was administered to managers of 194 Chilean manufacturing SMEs ranging in size from 10 to 250 employees. The Encuesta Nacional Industrial Anual (ENIA), developed by the Instituto Nacional de Estadística de Chile (INE) was used to obtain the population of the companies. The company managers' addresses and phone numbers were obtained from the Centro de Investigación y Desarrollo Sustentable (CIDES). Industrial sector classifications were taken from the Ministerio de Economía, Fomento y Turismo de Chile guidelines. However, to exclude companies with fewer than 10 employees, we followed previous studies, such as those by (Bogers et al., 2018) and (Radziwon and Bogers, 2019). Once the companies were filtered according to size, we selected the sample based on the principle of simple random sampling. Using simple random sampling, we were able to select a smaller sample size of a population based on predetermined criteria in order to generate a population-representative sample (in this case, sector and number of employees) (Brewer, 1999). We established

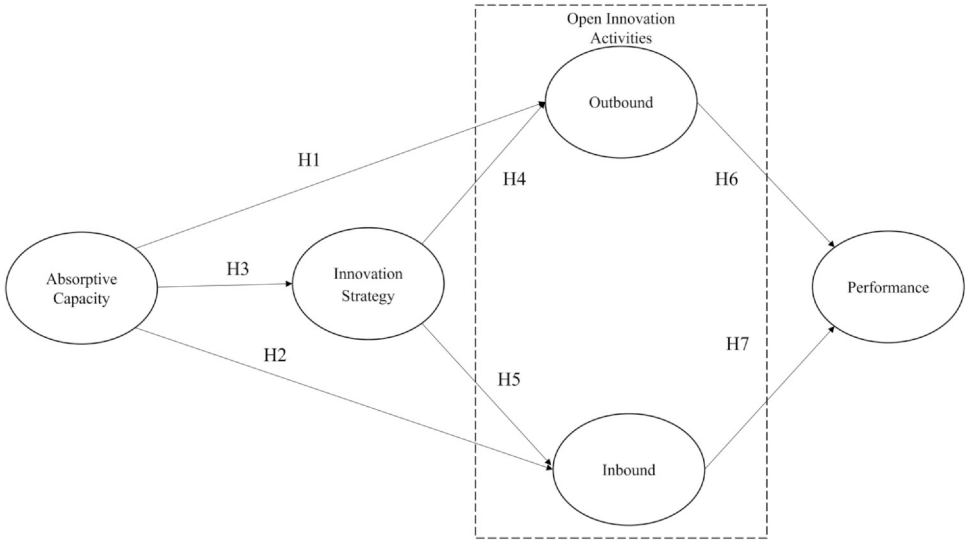

Fig. 2. Study hypotheses.
Source: Authors' design.

the size of the sample to meet two objectives. The first was to ensure that the sample was representative, with a sample error of 6.8% at a 95% confidence level. The second is to test the hypotheses of this quantitative research from the questionnaire applied using structural equations, which require specific rules. We used the PLS-SEM technique since it estimates models using an algorithm with a segmentation process that divides each model into subgroups (Hair et al., 2019) and allows at least 100 cases to be used to achieve adequate statistical power (Reinartz et al., 2009).

The unanswered surveys were randomly sent to companies of similar characteristics in the Región Metropolitana. The data was collected from August 2018 to February 2019. The surveys were distributed to the directors or managers of the sampled companies, as they typically make the most significant decisions in SMEs (Van Gils, 2005), and they directly influence the strategic behavior of their organizations (O'Regan and Sims, 2008).

Table 1 outlines the characteristics of the sample by sector.

Telephone appointments were set up to suit the participants. In these conversations, we explained the objective of the study and provided any additional information they required (Rosique-Blasco et al., 2018). In this way, we hoped to reduce bias and non-responses (Carter et al., 2014). Respondents were promised that the confidentiality of their responses would be maintained (Kariv et al., 2009), and control measures were built to prevent data entry errors.

To verify the understanding and suitability of the questionnaire, pretests were given to four managers (Collins, 2003). In addition, participants were informed that there were no correct or incorrect responses in order to prevent some questions from being overvalued (Yang et al., 2015). The anonymity and confidentiality of the submitted information were assured (Harms, 2015). To verify the quality of the information, an analysis of non-response bias was carried out (Nwachukwu et al., 1997), as well as a common method bias analysis (Podsakoff and Organ, 1986). These tests proved that bias was not relevant for the data used.

3.2. Measures

Based on the literature, a clear and simple questionnaire was designed, with careful attention paid to its structure. The questionnaire was given to managers of SMEs to collect the information necessary for our study.

Cross-sectional data with ordinal measures are provided. On a 5-point Likert scale, respondents were asked to indicate their level of total agreement or disagreement with each topic. The constructs used in this study are: absorptive capacity, innovation strategy, inbound, outbound, and innovation performance. They are latent variables measured formatively. Constructs can be measured formatively or reflectively, and their fundamentals are based on the nature of the construct (Henseler, 2017). When causality is produced from the construct to the indicators of the measures, they are called reflective (Hair et al., 2019), and they are designed to measure the underlying phenomenon (Chin, 1998). In contrast, when the indicators define the construct, they are called

Table 1
Sample of the companies in the study.
Source: Compiled by the authors.

Industrial Sector	Number ofcompanies	% of the Total
Food Production, Processing, and Conservation	33	17.01%
Metalic Structure Product Manufacturing	26	13.40%
Other Metal Product Manufacturing	23	11.86%
Printing and Related Support Activities	18	9.28%
Plastic Product Manufacturing	17	8.76%
Other Chemical Product Manufacturing	17	8.76%
Machinery For General Use Manufacturing	13	6.70%
Wood and Cork Product Manufacturing	13	6.70%
Furniture Manufacturing	12	6.19%
Textile Product Manufacturing	10	5.15%
Electrical Component Manufacturing	6	3.09%
Glass and Glass Product Manufacturing	6	3.09%
Total	**194**	**100%**

formative models (Diamantopoulos and Roth, 2008). That is, the indicators are the characteristics of the construct, and, in their totality, they explain the latent variable (Jarvis et al., 2003).

We have established the variables as formative composites, because of the assumption of correlation of the indicators. Based on the rationale proposed and supported by the studies of (Hair et al., 2014, 2016, 2017). It is important to note that constructs do not perfectly represent conceptual variables, as any concept and any construct definition has some degree of ambiguity associated with it (Sarstedt et al., 2016).

In a formative measurement model, indicators form the construct by linear combinations, a change in the value of an indicator due to, for example, a change in a respondent's assessment of the trait captured by the indicator, changes the value of the construct. What this means is that, by definition, constructs with a formative measurement model are inextricably linked to their measures (Diamantopoulos, 2006). Previous results show that for PLS involves virtually no bias when estimating data from a composite model population, regardless of whether the measurement models are reflective or formative (Sarstedt et al., 2016). Because formative measures need not be correlated and are assumed to be error-free, traditional reliability and validity assessment is considered not applicable (Bagozzi, 1994; Henseler et al., 2015, 2016). It makes no sense to examine the validity of these formative models in the same manner as reflective models (Chin, 2010).

3.2.1. Absorptive capacity

to measure this variable, we used the scale proposed by (Bojica and Fuentes, 2012) and adapted by (Yli-Renko et al., 2001). We included ten ítems, instructing the respondents to compare their companies to other companies in their industry and asking them whether their company occupies a very strong or very weak position.

3.2.2. Innovation strategy

this variable was measured following (Brunswicker and Vanhaverbeke, 2015), and it includes seven items the managers were asked about their agreement or disagreement.

3.2.3. Open innovation practices

the literature reflects heterogeneity concerning OI (Arbussã and Llach, 2018); It is a wide notion that is evaluated using a variety of metrics (Ahn et al., 2015; Greco et al., 2015). Therefore, there is no clear consensus about open innovation activities (Rodríguez-Ferradas et al., 2016). We followed (Van de Vrande et al., 2009). For **inbound** practices, we identified five items. Two ítems were used to measure ***outbound*** practices.

3.2.4. Innovative performance

Different dimensions of performance can be measured. One of these is the performance of innovations, which refers to the success companies achieve through new product, service, and technological innovations (Lu et al., 2020b). We measure this variable following (Gunday et al., 2011) and (Laforet, 2012). We consulted the managers about the achievements of their organizations in the following items related to innovation performance (1: not at all successful; 5: very successful).

The dimensions are listed in Table 2.

3.3. Statistical model

Multivariant analyses are advanced tools used to better understand the complexities arising in studies (Hair et al., 2019). Structural equation models (SEM) have been used to achieve a single, systematic, integrated analysis and to allow us to establish simultaneous relationships among the different variables (independent and dependent) (Gefen et al., 2000). The PLS technique (partial least squares) is based on an algorithm of alternating squared minimums, and it is the current tool used to model SEMs (Henseler, 2018).

SEM methods allow modeling relationships between multiple predictor variables and dependent or endogenous variables (Gefen et al., 2000). SEM analysis can be carried out by means of two types of statistical techniques (Barroso et al., 2010). The CBSEM approach seeks to estimate a set of model parameters so that the theoretical covariance matrix determined by the system of structural equations is as close as possible to the observed empirical convariance matrix (Reinartz et al., 2009). PLS works on blocks of (composite) variables and estimates model parameters by maximizing the explained variance of all dependent variables (Hair et al., 2019; Chin, 2010; Al-Emran et al., 2019). This technique is widely accepted, numerous PLS-SEM reviews show that the method became widely disseminated during the last decade, especially in the social sciences, but also in other fields of scientific research (Sarstedt et al., 2022).

From a measurement perspective, PLS and CBSEM share an approximation character as the constructs do not necessarily fully correspond to the conceptual variables they represent (Hair et al., 2017). Previous research shows that PLS-SEM is optimal for estimating composite models (Sarstedt et al., 2016).

The use of the methodology is supported by (Hair et al., 2019), as the model meets the conditions required for its use: That is: being complex; having an exploratory research objective and there is more than one formatively measured construct.

Causal studies are explanatory and confirmatory (Chin, 1998). Nevertheless, explanatory studies seek to explain a phenomenon, whereas the PLS technique relies on confirmatory research to demonstrate an auxiliary hypothesis. The purpose of this study is to determine, based on the existing literature, whether positive mediation exists between innovation strategy and outbound and inbound innovation activities (Henseler, 2018), which is a phenomenon that has not been studied before. We are also interested in determining how OI practices influence innovation performance in SME. This study aims to evaluate our hypotheses and optimize the variance of the dependent structure by employing explanatory strategies (Martelo-Landroguez et al., 2019) wherever the PLS technique allows us to establish these relationships (Henseler, 2018). In addition, path analysis permits us to simultaneously test different hypotheses (PLS-SEM) (Richter et al., 2016). PLS-SEM is appropriate for formative constructs because it separates measurement models from structural ones methodically (Nitzl et al., 2016; Rigdon et al., 2014). To run PLS –SEM, we used SmartPLS v,3.3.3, which allows hypotheses to be tested.

For formative measures, the correlation of indicators is not required, and reliability and validity tests are not applicable (Henseler et al., 2016). It makes no sense to examine the validity of these formative models in the same manner as reflective models (Chin, 1998). This study is comprised only of formative constructs.

4. Results

Table 2 presents the descriptive statistics (median and standard deviation) for the individual items. In terms of inbound activity, the most frequent practice is direct client participation in innovation processes. Developing new business using the company's own internal knowledge is the most prevalent outbound practice. Other OI activities are less prevalent among the investigated SME.

4.1. External Model (Measure)

Table 2 displays the Bootstrapping of 5000 samples used to estimate the model's t-tests. Here, we can examine the indicators' collinearity. Each VIF value is less than 3.3 (Diamantopoulos and Siguaw, 2006), indicating no collinearity is found in the items. No indication is omitted from the measurement model, taking into account the greatest attainable value, the relevance of the indicator weights, and the strong theoretical foundation for retaining them (Hair et al., 2019):

Table 2
Evaluation of multicollinearity between indicators and the applicability of weights.
Source: Authors' compilation

Construct	Item	VIF	Weight	T-statistic	P values
Absorptive Capacity	Item 1 Personnel with outstanding commitment to the development of the company	1.818	0.135	6.325	0.00
	Item 2 Technical experience	1.879	0.109	4.228	0.00
	Item 3 Experience in the development of products and services	2.099	0.107	4.094	0.00
	Item 4 Highly productive personnel	1.889	0.143	6.401	0.00
	Item 5 Experience in marketing	1.399	0.118	4.562	0.00
	Item 6 Specific customer service experience	2.002	0.178	8.894	0.00
	Item 7 Special experience in management	2.001	0.19	8.72	0.00
	Item 8 Knowledge about innovative markets	1.723	0.175	6.738	0.00
	Item 9 Personnel trained to give high-quality customer service	1.671	0.152	6.93	0.00
	Item 10 Whether the employees in the company like to contribute their ideas for new products or services	1.374	0.184	6.965	0.00
Strategy	Item 1 Their company's goal or mission includes a reference to innovation.	2.376	0.18	9.624	0.00
	Item 2 Innovation strategy has helped to achieve their strategic objectives	2.636	0.217	10.319	0.00
	Item 3 Internal cooperation is an important part of the implementation of the strategy	1.702	0.215	9.936	0.00
	Item 4 Customer satisfaction is part of their innovation strategy	1.726	0.161	7.257	0.00
	Item 5 Improving the quality of their products is one of the key objectives of their strategy	1.829	0.16	7.591	0.00
	Item 6 The design of their innovation strategy increases their employees' skills	2.074	0.173	8.889	0.00
	Item 7 Improving employee commitment and moral form a part of their innovation strategy.	1.835	0.231	9.957	0.00
Outbound	Item 1 Developing new business based on the company's internal expertise.	1.107	0.431	5.712	0.00
	Item 2 Utilizing the knowledge and initiative of individuals who do not work in R&D (Through ideas, for instance, a corporation would become less dependent on outside parties to produce innovations).	1.107	0.779	12.367	0.00
Inbound	Item 1 Direct client participation in innovation processes	1.34	0.321	6.086	0.00
	Item 2 Activities established through an external network foundation to foster innovation processes, resulting in the acquisition of external knowledge or human capital.	1.613	0.336	7.835	0.00
	Item 3 Participation in new and established companies to gain access to their knowledge and obtain other synergies	1.717	0.288	7.978	0.00
	Item 4 Employing R&D services from universities, public research institutions, engineers, or suppliers.	1.558	0.253	6.456	0.00
	Item 5 Purchasing or utilizing the intellectual property of other companies, such as patents, copyrights, or registered brands, in order to profit from their external expertise.	1.353	0.207	4.557	0.00
Performance	Item 1Their capacity to introduce superior new items and services than their competition	1.912	0.097	3.818	0.00
	Item 2 The quality of these new products and services	1.899	0.122	5.054	0.00
	Item 3 The boost in sales that these new products have created.	2.116	0.128	4.899	0.00
	Item 4 The increase in sales resulting from the modification of items	1.678	0.133	5.175	0.00
	Item 5 The effectiveness of delivery procedures within and beyond the organization	1.509	0.115	4.621	0.00
	Item 6 Enhanced procedures to save money and time	1.761	0.106	4.353	0.00
	Item 7 Efforts to simplify activities in order to improve organizational practices	1.715	0.132	5.868	0.00
	Item 8 Employee motivation to become more creative	2.039	0.189	8.063	0.00
	Item 9 Improvement in employee training	1.849	0.164	7.829	0.00
	Item 10 Improvements in team work	1.679	0.184	7.185	0.00
	Item 11 Greater promotion possibilities for employees due to innovation.	1.867	0.165	7.127	0.00

4.2. Internal Design (Structural)

The collinearity test shows VIF values of less than five (5), with no collinearity among the latent variables, as seen in Table 3:

Table 4 shows the bootstraps with 95% confidence intervals where the hypotheses are signed as expected. The table shows the algebraic signs (+,-), the coefficient value and the statistical significance of each path coefficient developed by the bootstrapping technique with 5000 samples. The table shows the positive and significant relationships of hypotheses H1, H3, H4, H5, H6 and H7. In addition to the beta value, algebraic positive sign and significance, the t values are adequate. These empirical tests provide support for our proposed theoretical model. In addition, percentile confidence intervals (CI) and corrected biases (CI) in which zero is not present are included, thus demonstrating the magnitude and impact of the relationships of the constructs in the model.

H1 was supported, demonstrating a favorable association between absorptive capacity and outbound innovation practices donde patch coef. = 0.231, t-value = 3.19 and p_value = 0000 support the direct effect. This is in line with other studies finding that greater absorptive capacity increases the creation of new businesses and patents (Avalos-Quispe and Hernández-Simón, 2019), and using internal knowledge improves commercial exploitation (Naqshbandi and Tabche, 2018). Absorptive capacity facilitates access to external technological resources and cooperation among companies (Greco et al., 2021). H2 is not supported practices where patch coef. = 0.079, t-value = 0.846 and

Table 3
Evaluation of collinearity among the latent variables.
Source: Authors' compilation

VIF Structural Model	Absorptive Capacity	Innovation Strategy	Inbound	Outbound	Innovation Performance
Absorptive Capacity		1.00	1.395	1.395	
Innovation Strategy			1.395	1.395	
Inbound					1.265
Outbound					1.265
Innovation Performance					

Table 4
Effects of the endogenous variable construct (including the lowest and highest limits of the 95% confidence intervals).
Source: Authors' compilation

Hypotheses	Patch Coef.	P values	5.0%	95.0%	Supported
H1: Absorptive Capacity → Outbound	0.231	0.00	0.081	0.367	Yes
H2: Absorptive Capacity → Inbound	0.079	0.39	-0.112	0.253	No
H3: Absorptive Capacity → Innovation Strategy	0.532	0.00	0.373	0.649	Yes
H4: Innovation Strategy → Outbound	0.192	0.01	0.03	0.337	Yes
H5: Innovation Strategy →Inbound	0.377	0.00	0.199	0.523	Yes
H6: Outbound → Performance	0.354	0.00	0.188	0.483	Yes
H7: Inbound → Performance	0.259	0.00	0.092	0.388	Yes

p_value = 0,39. That is, a positive relationship between absorptive capacity and inbound OI was not found. H3 is supported by the existence of a favorable correlation between absorptive ability and innovation strategy where patch coef. = 0.532, t-value = 3.8 and p_value = 0,00 that support the direct effect. Innovation plans can be more successful if companies are able to acquire, transform, and exploit external information (Müller et al., 2020), which help them find new business opportunities (Filipe and Moutinho, 2016). These results are consistent with our research. H4 with patch coef. = 0.192, t-value = 2.446 and p_value = 0,01 and la H5 conn patch coef. = 0.377, t-value = 4.6 and p_value = 0,00 that support the positive direct effect and in line with other studies where innovation strategy is positively related to open innovation practices (Barham et al., 2020; Lichtenthaler, 2011; Vanhaverbeke and Cloodt, 2014) and favor new business creation (Crema et al., 2014).

H6 with patch coef. = 0.359, t-value = 4.72 and p_value = 0,00 and H7 with patch coef. = 0.259, t-value = 3.4 and p_value = 0,00 are also supported by the results. Inbound and outbound innovation practices positively affect performance in SMEs. These findings are consistent with prior research indicating that external sources of knowledge, like as suppliers, clients, consulting firms, universities, and scientific publications, play crucial roles in enhancing the performance of innovative products and services (Leckel et al., 2020; Torres de Oliveira et al., 2020; Laursen and Salter, 2006; Chiang and Hung, 2010). Moreover, open innovation practices can bring companies together to form possible associations for new initiatives (Radziwon and Bogers, 2019). This could lead to radical innovations when the companies use new technologies and create new markets (Garcia Martinez et al., 2014; Barge-Gil, 2013). Our results empirically confirm that internal and external collaboration positively influence innovative performance in companies (Jugend et al., 2018).

Figure 3 depicts the structural model and outcomes.

4.3. Mediating Effects

Table 5 shows the results of the mediation hypotheses and their indirect effects. It shows the significant and positive indirect effects obtained by multiplying their betas. H1 and H6 from Absorptive Capacity to Outbound and then Innovation Performance with effect value 00. 82 (p1 * p6 = 0.231 *0.354 = 0.082); H5 and H7 from Strategy to inbound and then Innovation Performance with effect value 0.097 (p5 * p7 = 0.377 *0.259 = 0.097); H4 and H6 from Strategy to outbound and then Innovation Performance with effect value 0.068 (p4 * p6 = 0.192 *0.354 = 0.068); H1, H3 and H4 Absorptive Capacity to Strategy and outbound with effect value 0.102 (p3 * p4 = 0.532 *0.192 = 0.102); H2, H3 and H5 Absorptive Capacity to Strategy and inbound with effect value 0.201 (p3 * p5 = 0.532 *0.377 = 0.102). H3, H5 and H7 Absorptive Capacity a Strategy, a inbound and Innovation Performance with effect value 0.052 (p3 * p5 * p7 = 0.532 *0.377 *0.259 = 0.102). H2 and H7 Absorptive Capacity to inbound and Innovation Performance with effect value 0.02 (p2 * p7 = 0.079 *0.259 = 0.02). Finally, H3, H4 and H6 Absorptive Capacity to Strategy, to outbound and to Innovation Performance with effect value 0.036 (p3 * p4 * p6 = 0.532 *0.192 *0.354 = 0.036). The following hypotheses proposed in this study as mediating effects were then tested: H1, H3, and H4 propose that innovation strategy mediates between absorptive capacity and outbound open innovation practices; whereas H2, H3, and H5 suggest innovation strategy mediation between absorption capacity and inbound open innovation practices. In order to examine these mediation effects, both direct and indirect impacts in the paths were evaluated using the methods of (Zhao et al., 2010).

According to Table 5 and Figure 3, the indirect impact of absorptive capacity on outbound OI is substantial (0.102 t-value: 2.32). The direct effect of absorptive capacity on outbound OI (H1) is also significant. This indicates that the variable innovation strategy mediates

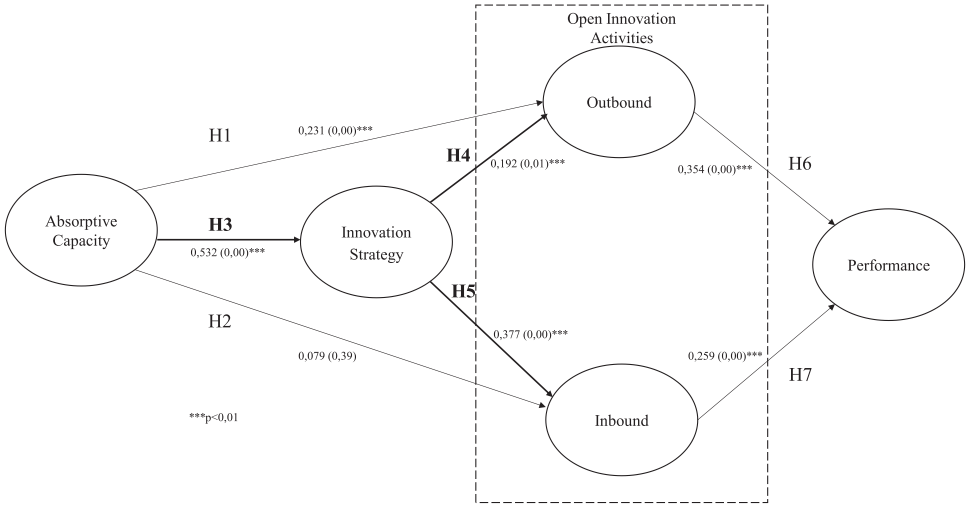

Fig. 3. Structural model, **Note**: The H in bold represents a direct effect (mediator). Significance is at 1%.
Source: Authors' design

Table 5
Specific indirect effects (including the lowest and highest limits of the 95% confidence intervals).
Source: Authors' compilation

Hypotheses		IndirectEffects	P Values	5.0%	95.0%	Supported
H1 and H6	Absorptive Capacity - > Outbound - > Performance	0.082	0.019	0.024	0.156	Yes
H5 and H7	Strategy - > Inbound - > Innovation Performance	0.097	0.008	0.034	0.177	Yes
H4 and H6	Strategy - > Outbound - > Innovation Performance	0.068	0.052	0.011	0.147	Yes
H1, H3, and H4	Absorptive Capacity - > Strategy - > Outbound	0.102	0.021	0.019	0.191	Yes
H2, H3, and H5	Absorptive Capacity - > Strategy - > Inbound	0.201	0.000	0.111	0.305	Yes
H3, H5, and H7	Absorptive Capacity - > Strategy - > Inbound - > Performance	0.052	0.013	0.018	0.099	Yes
H2 and H7	Absorptive Capacity- > Inbound - > Performance	0.02	0.48	-0.022	0.087	No
H3, H4, and H6	Absorptive Capacity - > Strategy - > Outbound - > Performance	0.036	0.066	0.006	0.083	Yes

(complementary mediation) between absorptive capacity and outbound OI practices. Therefore, the mediation proposed is supported by these results. The indirect effect of absorptive capacity on inbound OI practices is significant (0.201 t-value: 4.052), however the direct effect is not (H2). This indicates that the variable innovation strategy is a mediator (total mediation) between absorptive capacity and inbound OI practices. Therefore, the mediation proposed is supported by the results.

The f^2 impact size quantifies the extent to which an exogenous construct contributes to the R^2 explanation of an endogenous construct. The absorptive capacity construct on strategy is expansive, at $f^2 = 0.395$, while the relationship between absorptive capacity and outbound ($f^2 = 0.044$), innovation strategy and outbound ($f^2 = 0.031$), innovation strategy and inbound ($f^2 = 0.124$), outbound and performance ($f^2 = 0.136$), and inbound and performance ($f^2 = 0.073$) are small. The relationship between absorptive capacity and inbound ($f^2 = 0005$) is weak. In Table 6, the effect size is shown.

5. Discussion

This investigation focused on open innovation practices demonstrates the role absorptive capacity plays in SME outbound and inbound OI activities. The initial hypothesis demonstrates a positive correlation between absorptive capacity and outbound OI practices. This result is consistent with the findings of (Naqshbandi and Tabche, 2018), which indicate that firms with higher degrees of absorptive capacity get better success in outbound open innovation. Absorptive capacity is important because it leads to new businesses and patents (Avalos-Quispe and Hernández-Simón, 2019) and is a prerequisite to open innovation success (Idrissi and Castonguay, 2019; Fertő et al., 2016). Our results are consistent with findings found in other parts of the world such as emerging countries that show the role of absorptive capacity in IoT practices (Cuevas-Vargas et al., 2022). Our finding of the positive impact of absorptive capacity on open innovation practices has two important implications. The first is that the theory is confirmed, firms with greater ability to capture the value of new external knowledge and integrate it (Zahra and George, 2002) can start new businesses from internal knowledge and secondly take better advantage of the knowledge and initiatives of employees who are not directly involved in R&D.

Table 6
f^2 effect size of the structural model.
Source: Authors' compilation

	f^2	Effect
H1: Absorptive Capacity - > Outbound	0.044	Small
H2: Absorptive Capacity - > Inbound	0.005	Weak
H3: Absorptive Capacity - > Strategy	0.395	Large
H4: Innovation Strategy - > Outbound	0.031	Small
H5: Innovation Strategy - > Inbound	0.124	Small
H6: Outbound - > Performance	0.136	Small
H7: Inbound - > Performance	0.073	Small

The result of the second hypothesis shows an indirect effect of absorptive capacity on inbound practices, showing a relevant result with 1) the total mediation of innovation strategy between absorptive capacity and inbound OI activities. The results of hypothesis four show 2) the complementary mediation of innovation strategy between absorptive capacity and outbound OI practices. Hypothesis three supports these mediations with a positive relationship between absorptive capacity and innovation strategy. The literature states that absorptive capacity and innovation strategy have a positive relationship (Díaz-Díaz and de Saá Pérez, 2014). Our results are consistent with other results found in the world (Mirza et al., 2022), where Innovation plans might be more successful if companies are able to obtain, transform, and utilize external knowledge (Müller et al., 2020), and these strategies help them find new business opportunities (Filipe and Moutinho, 2016).

The fourth and fifth hypotheses likewise support the mediations and demonstrate a favorable correlation between innovation strategy and inbound and outbound OI activities. The literature indicates that innovation strategies encourage companies to open toward their external environments (Crema et al., 2014) and promote the development of innovation practices (Verbano et al., 2015). Other studies show that OI is a valuable innovation strategy to increase companies' competitive advantages (Brunswicker and Ehrenmann, 2013; Natalicchio et al., 2017). Then companies that consider in the strategy innovation in their mission, rich internal cooperation to implement the strategy, customer satisfaction as a relevant factor, continuous product improvement, improvement of employees' skills during the process of innovation strategy formulation and also in the process of monitoring the strategy the improvement of employees' commitment is considered, have a higher probability to develop more inbound and outbound open innovation activities.

Hypotheses six and seven show significant evidence relating outbound and inbound OI practices and business innovation performance. This outcome provides empirical data validating the literature that SMEs can improve their technology status and get access to new markets (Popa et al., 2017), and deliver innovations to markets quickly (Albats et al., 2020). SMEs' innovation capabilities are found to be significantly enhanced by both inbound and outbound OI operations, according to the study's findings. This is consistent with previous research (Radziwon and Bogers, 2019; Greco et al., 2021; Setini et al., 2020).

This research also offers results showing significant indirect effects, with absorptive capacity playing a key role. Absorptive capacity indirectly affects performance through outbound practices, as hypotheses one and six demonstrate. Theories 3, 5, and 7 explain how absorptive capacity affects performance in a more indirect way by influencing innovation strategy and inbound OI activities. Innovation strategy and outbound OI activities are examples of how absorptive capacity indirectly impacts performance through hypotheses 3, 4, and 6.

On the other hand, the theory of resources and capabilities arises from the idea that considers the study of organizational strategy as a process that seeks business profitability and obtaining competitive advantages from the internal factors of the company (Barney et al., 2021).

It is a theory that provides the conceptual tools that help explain the process of obtaining these competitive advantages based on the resources and capabilities available to the organization (Wang, 2014; Peteraf and Barney, 2003). The resource-based view applied to open innovation could be useful to explain the costs and benefits of collaboration. First, knowledge collaboration is associated with the acquisition of knowledge that is not available within a firm (Bogers et al., 2018; Chesbrough et al., 2006; Audretsch and Belitski, 2023). Our results confirm that resource and capabilities theory and dynamic capabilities explain how firms build competitive advantage (Vanhaverbeke and Cloodt, 2014; West and Bogers, 2017) in this case absorptive capabilities are the necessary driver and an important precondition for the renewal of a firm's knowledge base (Zahra and George, 2002). This, in turn, leads to a higher rate of innovation and greater flexibility in the reconfiguration of the resource base (Miroshnychenko et al., 2021).

6. Conclusions

In the context of SMEs, the purpose of this study was to investigate how absorptive capacity can encourage inbound and outbound open innovation practices, the role that innovation strategy plays as a mediator in this relationship, and the impact that this relationship has on performance. To do this, we surveyed 194 manufacturing SME's in the Metropolitan Region of Chile. The findings demonstrate a positive correlation between absorptive capacity and inbound and outbound open innovation activities. These results are consistent with those found in other studies (Spithoven et al., 2010). The innovation strategy approach mediates between absorptive capability and open innovation techniques. Innovation strategy is a total mediator between absorptive capacity and inbound practices, and it is a complementary mediator in outbound activities.

This study has significant managerial and public policy consequences (Yun and Liu, 2019). The results indicate, from the perspective of SME management, that managers and owners of SMEs exhibit the following traits: (1) that companies with adequate absorptive capacity can better evaluate their surroundings with new technologies and add new external knowledge to their innovation processes (Ahn et al., 2016; Agostini et al., 2017). They can better develop their inbound open innovation practices (Lu et al., 2020b) and increase the creation of new businesses (Naqshbandi and Tabche, 2018); (2) the importance absorptive capacity has in developing an innovation strategy and finding new business models (Müller et al., 2020); (3) that innovation strategy helps open companies to their external environments (Barham et al., 2020) and helps develop better open innovation practices (Crema et al., 2014). Moreover, OI is a valuable innovation strategy to increase companies' competitive advantages (Brunswicker and Ehrenmann, 2013; Natalicchio et al., 2017). From the public policy perspective, this study provides relevant information for decision-makers. OI is a valuable innovation strategy to increase competitive advantages (Brunswicker and Ehrenmann, 2013; Natalicchio et al., 2017).

Inbound OI practices are key to improve cooperation with universities and public institutes that positively increase the innovative performance of SMEs, our results are in line with other studies (Lopes et al., 2021).

In light of the fact that these skills boost innovation strategies and raise inbound and outbound OI practices, public bodies should foster initiatives to encourage the development of absorptive capacity skills.

Lastly, we would like to note that our study has several limitations that could be explored in future studies. First of all, the size of our sample prevents it from being representative and it is focused on a specific geographic location (Chile) and industrial sector (manufacturing). Other studies could confirm our results for other emerging countries and other sectors. Secondly, we have used a approximate to measure absorptive capacity in SMEs. In future studies, this construct should be studied more deeply. Future research plans could address longitudinal studies to verify the usefulness of open innovation activities to improve SME competitiveness, using structural equations in the context of time series. Another future line of research may be to approach the proposed structural model using the CB-SEM technique to test the hypotheses. Additionally, studies that consider the technological degree and dynamism of the industrial sectors could strengthen the results obtained in this work.

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