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The role of information sources as a driver of innovation

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Abstract

An extensive empirical literature shows the important role that information sources have on firm innovation. However, there is scarce evidence on the different typologies of between technological and non-technological innovations and their expectations. We investigate how the wide number of information sources affect the propensity to innovate and its future expectations. At the methodological level, we apply a multivariate Probit to the Innovation Survey of Chilean companies (2013–2016). Our results show that internal information sources, suppliers, clients and the Internet are significantly associated with the development of technological and non-technological innovations. Social innovations are affected only by internal and by market (primarily from consultancy firms) sources of information. Finally, internal information sources and the Internet affect firms' expectations to innovate. Our results indicate the importance of different information flows and how they may drive the generation of innovations.

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1 | INTRODUCTION

A wide range of the literature has highlighted the role of information sources to promote firm innovation (Laursen & Salter, 2006). Information sources are considered a relevant driver (Medhi et al., 2019) of the development and generation of knowledge which, in turn, may trigger innovation (Iwasa & Odagiri, 2004). However, the role of information sources as determinants of innovation largely remains unknown to non-technological innovations (particularly social innovations) and expectation of innovating. This point is particularly relevant given the importance of information flows between agents with modern strategies such as open innovation or frugal innovations. These different information sources may facilitate firms in accessing new knowledge or even opening new technological paths.

These sources may not only trigger current innovations but also affect the expected innovation outcomes. Expectation to innovate depends on a firm's perceptions, and information sources facilitate firms in facing challenges, defining strategies, allowing greater competitivity, and consequently improving their performance in both the short and the long term. Among the few studies analysing the determinants of firms' expectations to innovate are Lin and Ho (2008), Mothe and Nguyen-Thi (2012), Geldes et al. (2017) and Beynon et al. (2018). These studies identify a certain innovation persistence since firms that have already carried out some type of innovation have a greater propensity to develop future innovations. However, while expectations are driven by experience, the role of information sources has been neglected in this field.

The analysis of information sources is particularly relevant for less developed countries because their costs may differ. Since there is a need to increase their levels of innovation, Latin American countries are especially sensitive to this issue. Works by Holm-Nielsen and Agapitova (2002), Lederman and Maloney (2004), Benavente et al. (2005, 2005), Benavente (2005), Benavente (2006), Santoleri (2015), Araneda-Guirriman et al. (2015), Geldes et al. (2017) and Pérez et al. (2019) have analysed the determinants of the development of innovation in this region. However, these studies focus mainly on technological (product and process) innovations and have less emphasis on their non-technological counterparts (organisational, marketing and social innovations).

This study aims to examine how information sources affect the probability of developing innovations and the consequent expectations for Chilean firms. The database is the Chilean Innovation Survey (2013–2016) developed by the Ministry of Economy, Development and Tourism, which follows the general guidelines suggested by the *Organisation for Economic Cooperation and Development* (OECD) and Eurostat's CIS (*Community Innovation Survey*). At the methodological level, we apply a multivariate Probit model distinguishing between technological and non-technological innovations. The results indicate that sources from within the firm, suppliers, customers and the Internet are significant drivers for the development of both technological and non-technological innovations. However, social innovations essentially have only two sources: information from within the organisation and from market sources (specifically from consultancy firms). Finally, regarding the expectations to innovate, internal information sources and the Internet affect a firm's expectation of developing either technological or non-technological innovation.

This article makes several contributions. First, while there is wide evidence on technological innovations, this study addresses how the information sources differ across all types, including social innovation. Information is the flow of potential knowledge that can contribute to a firm's capacity to generate all types of innovations. Nowadays, this analysis is of increasing importance when the knowledge required to develop new innovations is more complex due to the difficulty of generating new innovations. The analysis of information sources is also necessary since it is crucial to a firm's innovation model. Our study contributes to this analysis and points out different strategies for a less developed country such as Chile. Second, we analyse not only the innovative capacity but also the expectation of future innovation. Our analysis allows studying the drivers of a firm's propensity to innovate in the future in relation to the actions carried out and the role that information sources have on the generation of expectations. The generation of innovative outcomes may be subject to particular information flows. Finally, our research includes a new typology of non-technological innovation such as social innovation. To the best of our knowledge, none of these aspects have previously been addressed in the literature.

The structure of the paper is as follows. The second section develops the literature review on the role of information sources in innovation. The following section presents the database, the main statistics and the econometric methodology applied. The fourth section develops the analysis of the results and their interpretation. We conclude by outlining the public policies that emerge from our results.

2 | LITERATURE REVIEW: INFORMATION SOURCES AS A FACTOR OF INNOVATION

2.1 | The role of information in generating innovations

Inherent in the theme of information is the concept of knowledge. According to the OECD, knowledge refers to the understanding of information and the ability to use it for various purposes. A firm can harvest it from freely available information, acquire it externally, or develop it in cooperation with other companies or research centres. Knowledge can be developed within organisations, or by external agents, and captured by the firm. Regardless of its origin, it is considered one of the main strategic resources required to initiate innovation processes.

From this perspective, it is essential to have the information systematically available in addition to having the organisational ability to make effective use of it. Such an absorption capacity allows the firm to recognise the value of new information, assimilate it and apply it for commercial purposes (Cohen & Levinthal, 1990; Fosfuri & Tribó, 2008; Ince et al., 2016; Nieto & Quevedo, 2005; Rezk et al., 2015). Caloghirou et al. (2004) defined this capacity as the ability of a firm to absorb knowledge and information from external sources. These authors considered it as one of the pillars for transforming knowledge, thereby generating value for firms and improving their innovative performance.

Concerning the typologies, various authors have identified the sources of information used by companies as drivers of a firm's innovations (Amara & Landry, 2005; Bach et al., 2015; Cassiman & Veugelers, 2006; Leiponen, 2001; Llopis, 2018; Medhi et al., 2019; Pérez et al., 2019; Prokop & Stejskal, 2017; Robin & Schubert, 2013; Tödtling et al., 2009; Varis & Littunen, 2010; Veugelers & Cassiman, 1999a; Volpi, 2017). Varis and Littunen (2010) adopt both micro and meso level approaches. At the micro level, the authors emphasise the role of internal information sources (related to tacit knowledge) while, at the meso level, external relations (related to codified knowledge) appear. Indeed, each type of information may be best suited to specific innovation types (product, process, marketing, organisational and social). Hence, it is important to analyse each of them separately and clearly identify which sources of information are significant for the development of several types of innovations.

Consequently, it is not only useful, but necessary, to study the sources of the information used by firms (Varis & Littunen, 2010) since they may contribute to the development of knowledge resulting in the generation of specific types of innovations (Iwasa & Odagiri, 2004).

Table 1 identifies the different types of information sources available to a firm. The disaggregation of the sources of information is relevant in understanding which of them affect a firm's performance and thereby impact on its innovation.

First, internal sources of information come from within the firm, where tacit knowledge is generally present. This knowledge originates in peoples' minds, in the information incorporated into the 'routines' of firms or is based on experience (Montuschi, 2001). This information facilitates the generation of innovation and fosters firms' absorptive capacity.

Second, firms need to complement internal information sources (Santamaría et al., 2009) with external information sources, where codified knowledge is predominant. External information sources arise from the generation of networks and through transfer processes (Montuschi, 2001). The market is also a good information source and, according to Medhi et al. (2019), it is divided into clients (Demonaco et al., 2020; Von Hippel, 2017), suppliers (Leiponen, 2001; Oerlemans

TABLE 1 Sources of information used to carry out innovation in companies.

Information sources	
Internal sources	Generated within companies
Market sources	Suppliers
	Customers
	Competitors or other companies in the same sector
	Consultants, commercial laboratories, or private R&D institutes
Institutional sources	Universities or other institutes of higher education
	Public or government research institutes
Other sources	Conferences, fairs, exhibitions, scientific journals, associations, the Internet, etc.

Note: Summary obtained from the Chilean Innovation Survey.

et al., 2001), competitors and consultants, commercial laboratories, and/or private R&D institutes. Moreover, there are institutional sources (Amara & Landry, 2005; Zemplinerová & Hromádková, 2012) that encompass Higher Education Institutions (Laursen & Salter, 2004; Pérez et al., 2019; Robin & Schubert, 2013) and public or government research institutes. Finally, fairs and exhibitions (Amara & Landry, 2005; Evers and Knight (2008) and the Internet (Soto-Acosta et al., 2010) are additional information sources.

We must also bear in mind that the use of multiple sources of information contributes to generating benefits for the development of firms' innovations, since it is possible to develop complementarities and synergies between various sources of knowledge (Amara & Landry, 2005; Bigliardi & Dormio, 2009) and consequently to make better decisions (Prokop & Stejskal, 2017).

By accessing a more significant number of information sources, firms improve the probability of generating knowledge, thus leading to successful innovation outcomes. However, according to Leiponen (2001), firms may have higher marginal costs due to the increased complexity of managing the variety of knowledge and relationships necessary to maintain access to these sources.

2.2 | The influence of information typologies on innovation

A large number of studies indicate that external information sources are positively associated with innovations (Ahuja & Katila, 2001; Laursen & Salter, 2006; Varis & Littunen, 2010; Veugelers & Cassiman, 1999b). Additionally, authors such as Griffith et al. (2006) find that the successful development of product innovations depends positively on information sources from customers and/or suppliers, while process innovation development is more likely in firms which use information from both suppliers and competitors.

In turn, Medhi et al. (2019) confirm that information sources from relationships with new customers or suppliers influence the production of innovations in the immediately following period. Similarly, Zhang and Chen (2008) identify that, through dialog and interactions with the firm, customers can provide information about their needs, requirements, operations and environmental contexts. Customers are also an important source of new ideas for improving existing products or services.

Suppliers can exchange knowledge and resources involved in the internal operations of firms (Flynn et al., 2010; Yeung et al., 2009). However, it is necessary to emphasise that, to improve the results of innovation, all the departments within a firm should be integrated. This allows an improvement in internal information processing capacities (Zhang et al., 2014). Moreover, cooperation between different areas facilitates better absorption of knowledge obtained from suppliers and customers (Grant, 1996), resulting in innovation development.

Furthermore, Caloghirou et al. (2004) conclude that both internal capabilities and openness to the exchange of knowledge, mainly generated by scientific and business journals, are significant in improving innovative performance. In turn, Amara and Landry (2005) indicate internal and institutional sources of information as significant for the development of product innovations.

With respect to the results associated with non-technological innovations, Varis and Littunen (2010) found that there is an association with different freely accessible information sources with marketing innovation and the information acquired through the various network relationships of companies, while regional educational and research organisations seem to be linked to the introduction of organisational innovations.

Regarding the typologies of innovation, most research on information sources as a factor in the development of firm innovation focus on technological innovations (Amara & Landry, 2005; Bigliardi & Dormio, 2009; Griffith et al., 2006; Ince et al., 2016; Llopis, 2018; Medhi et al., 2019; Robin & Schubert, 2013). Due to the scarce available research on non-technological innovations, we consider it necessary to study this area. Consequently, our first hypothesis is

> **Hypothesis (1):** Information sources have different relationships to technological than to non-technological innovations.

It is proposed that technological and non-technological innovations have a differential impact depending on the type of innovation. The sources of information used may vary depending on the types of innovation developed, given that the units responsible for these innovations may be different. This is because each unit seeks to solve specific needs in its area, which leads to a differentiated search and use of information. Furthermore, it is important to recognise that both the development of technological and non-technological innovations, and in particular social innovation, may require access to different types of knowledge, skills, and attitudes, and, therefore, to various sources of information.

According to the authors, Varis and Littunen (2010), and in the context of organisational innovation, the information sources used come from specialised networks, such as higher education institutions and research institutes. This focus on academic and specialised sources is largely due to the possibility of accessing advanced

knowledge from experts and specialists. This information allows us to promote innovation within organisations through the incorporation of new technologies, management models and other practices.

But, however, in the field of marketing and product innovation, free sources of information may be more common. This could be due to the direct relationship between product innovation and the exploration of new markets.

2.3 | Information as a driver of the expectation to innovate

Few studies analyse the drivers affecting the expectation of innovating by a firm, and unsurprisingly, they do not include the information sources as a determinant. In the scant literature, Beynon et al. (2018) identify that an SME's intention to innovate is affected by factors such as the number and training of personnel, the number of stores or branches (and their online presence), R&D expenditure, international presence, marketing and advertising expenditures. All these factors are positively associated with the intention to innovate. The main reason is that firms with all these drivers are developing a strategy to innovate, and consequently, they tend to show less uncertainty regarding developing future innovations.

Additionally, Geldes et al. (2017) present a similar study. They explain how the intention to innovate differs between firms that have already developed technological as opposed to non-technological innovations. The authors focus on the intention to innovate for firms belonging to the agriculture, manufacturing and service sectors. Concerning the intention to innovate in product, the main factors are having previously developed some innovations in products or in marketing and R&D. Regarding the intention to innovate in process, the only positive effect is having developed organisational innovations. Regarding the intention to innovate organisationally, for manufactures, only having developed organisational innovation and the development of patents have positive effects. However, for services, product and organisational innovations are related to the propensity to innovate in the process. While in the case of the manufacturing and service sectors, having developed innovation in marketing increases the propensity to innovate in marketing. Therefore, this work highlights the presence of a series of interrelations between the development of innovations and the expectation of developing future innovations.[1] Furthermore, Mothe and Nguyen-Thi (2012) find that, especially for service companies, both organisational and marketing innovations led to a greater propensity to introduce new or improved products. Consequently, our second hypothesis will test the following:

> **Hypothesis (2):** The expectation to innovate depends on the previous innovative capacity.

The expectations to innovate may also be affected by the information sources. However, the latter have a different nature due to the risk and because the existence of an expectation implies the existence of a certain planning of the innovation process. Hence, it is necessary to estimate which of them can affect the future intentions of firms. We assume that not all the typologies of information sources can generate significant impacts in the expected outcome.

Therefore, firms form their expectations based on past events and the learning they have had over time. This is mainly because they do not develop analyses of their environments to make decisions, added to the uncertainty that the process entails. For the formation of perceptions, it is necessary to process a large amount of information; therefore, knowing which of it is relevant to form the expectations to innovate is crucial. Hence, the information used by firms will be relevant in knowing their expectations to innovate (Coibion & Gorodnichenko, 2015) as well as their previous experience. Thus, one further hypothesis will be

> **Hypothesis (3):** The expectation of developing technological and non-technological innovations depends on both internal and external sources of information.

3 | DATABASE, VARIABLES AND ECONOMETRIC METHODOLOGY

3.1 | Database

The database used is the 9th and 10th Innovation Survey for the periods 2013–2014 and 2015–2016, respectively, developed by the Ministry of Economy, Development and Tourism. We should note that the database does not allow us to generate a panel data.

The initial sample contains 11,496 observations, but we apply different filters. We exclude public firms, those with 0 sales or with 0 workers in both periods, and firms that have more than 50% of workers linked to innovation but which do not carry out innovations or have innovation expenditures. Finally, we select firms corresponding to medium-low, low, medium-high and high-tech sectors, leaving a final sample of 4226 companies.

The survey measures, among others, the type of innovation that a firm develops, its expectations of innovating, characteristics, and its economic sector, together with the activities and expenses of innovation. Two waves are considered for the study, but it is not possible to form a data panel by identifying the companies that respond in each period.

3.2 | Variables

The dependent variables of our study are the following. First, we have five dichotomous variables that correspond to each type of technological (product, process) and non-technological (marketing, organisational and social) innovations. Second, we also generate five dummy variables that represent the expectation to innovate to each type of innovation.

TABLE 2 Description of the variables.

Variable name	Description and authors
Dependent variables	
PD, *PC*, *MARK*, *ORG*, *SOC*	Dummies for each type of innovation: Goods and/or services, process, organisational, marketing and social. Authors: Araneda-Guirriman et al. (2015), Bala Subrahmanya (2013), Benavente et al. (2005, 2005), Benavente (2005), Benavente (2006), Cassiman and Veugelers (2006), Crespi and Zuniga (2012), Geldes et al. (2017), Griffith et al. (2006), Holm-Nielsen and Agapitova (2002), Lederman and Maloney (2004), Llopis, E. J. (2018), Medhi et al. (2019), Nieto and Santamaría (2010), Pérez et al. (2019), Santoleri (2015), Robin and Schubert (2013), Terjesen and Patel (2017), Tödtling et al. (2009), Varis and Littunen (2010), Veugelers and Cassiman (1999a), Volpi (2017) and Zemplinerová and Hromádková (2012)
ExpPD, *ExpPC*, *ExpMARK*, *ExpORG*, *ExpSOC*	Dummies that indicate whether the firm intends to carry out any innovation activity in product, process, marketing, organisational and social innovations. Beynon et al. (2018), Geldes et al. (2017), Lin and Ho (2008) and Mothe and Nguyen-Thi (2012)
Independent variables of sources of information	
Internal, *suppliers*, *customers*, *competitors*, *consultants*, *HEI*, *government*, *conferences*, *journals*, *associations*, *Internet*	Dichotomous variables for information sources for the development of innovations. The categories are whether the firm used internal sources (generated within the firm), market sources (suppliers, customers, competitors, or consultants), external institutions (universities and research institutes), public and government research, or other sources (conferences, fairs, exhibitions, scientific journals, technical and trade publications, technical and professional associations, and the Internet). Authors: Amara and Landry (2005), Bach et al. (2015), Bala Subrahmanya (2013), Cassiman and Veugelers (2006), Crespi and Zuniga (2012), Griffith et al. (2006), Leiponen (2001), Medhi et al. (2019), Pérez et al. (2019), Prokop and Stejskal (2017), Robin and Schubert (2013), Santamaría et al. (2009), Tödtling et al. (2009), Varis and Littunen (2010), Veugelers and Cassiman (1999a), Volpi (2017), Zemplinerová and Hromádková (2012).
Diversity	The 'diversity' of the information sources indicates the number of information sources used by each firm. The variable has a value of 11 when all the sources are used, and it decreases as the number of information sources used diminishes to 0 when no information source is used. Authors: Laursen and Salter (2006), Terjesen and Patel (2017)
Independent variables of R&D	
Natcoop Intercoop	Dichotomous variable that indicates whether the firm has carried out collaborative actions developed with national companies (Natcoop) or foreign companies (Intercoop). Authors: Amara and Landry (2005), Crespi and Zuniga (2012), Frenz and Ietto-Gillies (2009), Griffith et al. (2006), Leiponen (2001), Llopis (2018), Martínez-Román et al. (2011), Nieto and Santamaría (2010), Pérez et al. (2019), Prokop and Stejskal (2017), Robin and Schubert (2013) and Tödtling et al. (2009)
Internal_RD_1_ln *External_RD_1_ln*	Internal and external R&D expenditure invested by a firm in period 't − 1' (logs). Authors: Amara and Landry (2005), Bach et al. (2015), Cassiman and Veugelers (2006), Frenz and Ietto-Gillies (2009), Llopis, E. J. (2018), Martínez-Román et al. (2011), Nieto and Santamaría (2010), Pérez et al. (2019), Santos et al. (2014), Terjesen and Patel (2017), Tödtling et al. (2009), Veugelers and Cassiman (1999a), Volpi (2017), Zemplinerová and Hromádková (2012), Coad et al. (2016), Stam and Wennberg (2009)
Independent variables of firms' characteristics.	
Sales_1_ln	Sales in period 't − 1' (logs). Authors: Bach et al. (2015) Bala Subrahmanya (2013), Cassiman and Veugelers (2006), Frenz and Ietto-Gillies (2009), Santamaría et al. (2009) and Terjesen and Patel (2017)
Age_ln	Firm age (logs). Authors: Bala Subrahmanya.(2013), Becheikh et al. (2006), Leiponen (2001), Martínez-Román et al. (2011), Nieto and Santamaría (2010), Santamaría et al. (2009) and Terjesen and Patel (2017)
Perprofessionals_1	Percentage of professionals including doctorates and masters in 't − 1'. Authors: Frenz and Ietto-Gillies (2009), Martínez-Román et al. (2011), Pérez et al. (2019), Santos et al. (2014) and Tödtling et al. (2009)
Expo_1	Percentage of exports over sales in period 't − 1'. Authors: Bach et al. (2015), Becheikh et al. (2006), Cassiman and Veugelers (2006), Crespi and Zuniga (2012), Frenz and Ietto-Gillies (2009), Leiponen (2001), Jové-Llopis (2018), Nieto and Santamaría (2010), Pérez et al. (2019), Veugelers and Cassiman (1999a) and Volpi (2017)
High_tech, *Low_tech*, *High_techserv*, *Low_techserv*	Dummy that identifies high and medium-high technology sectors, low and medium-low technology, as well as knowledge-intensive and low-intensity services. Authors: Amara and Landry (2005), Cassiman and Veugelers (2006), Robin and Schubert (2013) and Tödtling et al. (2009)
Capital	Dummy that identifies whether a firm is in the Chilean capital, Santiago.

(Continues)

TABLE 2 (Continued)

Variable name	Description and authors
Public instruments	
Public_instrument	Dummy that indicates whether the firm requested any public instrument to finance its innovation activities. Authors: Amara and Landry (2005), Bach et al. (2015), Crespi and Zuniga (2012) and Pérez et al. (2019)
RD_Law	Dummy that indicates whether the firm applied to the R&D law tax incentive

Source: Compiled by the authors.

Concerning our key variables, we include dummy variables to control for R&D cooperation (national or international), the R&D expenditure (internal or external), and those variables linked to the sources of information used to develop innovations, among others internal, external, market and external institutions.

Additionally, we include as control variables some firm characteristics such as whether the firm is in Santiago, firm age, the share of professionals, technological level, whether it exports, if it has received any governmental support to develop innovations, and if it has applied for R&D tax incentives. Table 2 presents the details of the variables.

3.3 | Descriptive statistics

The following subsection presents a descriptive analysis of the most relevant variables, detailing whether the firm carries out at least one type of innovation.

Table 3 presents an analysis of the expectation of the different types of innovation for firms that have already developed innovations. The results show that firms that have developed some type of innovation, mostly present higher expectation of innovating in the future in all types of innovation. A relevant fact is that those firms that carried out social innovations present a greater expectation to innovate in the future regardless of the innovation type (with a higher percentage to innovate in product 89.0%, in processes 84.6%, social 80.0%, organisational 74.7% and, to a lesser extent, 69.2% expect to develop innovations in marketing). Conversely, firms that have not developed social innovation, yet have developed another type of innovation, have a low interest (approximately 35%) in developing social innovation.

Table 4 shows that internal information is the most used source for developing innovations, regardless of the typology. Particularly, firms that develop social innovations declare more frequently that this is the main (79%) source, followed by those developing product innovations (69%), and similar percentages emerge for innovations in process, marketing and organisation. Table A1 presents the descriptive statistics for the analysed variables.

Second, information obtained from the Internet is one the most common sources used by firms. It is used by 55% of firms that develop social innovations, 47% by those that carry out marketing innovations, 46% for product innovations, 43% for process innovations and finally 41% for organisational innovations.

The third information source is that coming from suppliers, where 43% of the companies that carry out product innovation use them, followed by companies that have developed social (51%) and process innovations (44%).

Finally, the sources of information from customers are used by 49% of firms that carry out product and social innovations, 47% of those developing marketing innovations and 42% for firms that carried out organisational and process innovations.

The least used sources of information correspond to sources from the government, technical associations, and institutional sources. Finally, the data reflect that most firms use internal information sources, from customers, the Internet, and their suppliers, to develop some type of innovation.

When analysing firms that have expectations of innovating in the future, we observe that the percentage of those that use information sources is lower compared to those that are already innovating. However, internal sources, suppliers, customers, and the Internet continue to be the most used, and this pattern is repeated both in firms that are innovating and in those that expect to.

3.4 | Econometric methodology

To estimate the determinants that affect the probability of innovating and its expectations, we consider the probability that there are unobserved factors that simultaneously affect the five types of innovation. For this reason, we consider a multivariate Probit model (Greene, 1996).

First, we analyse how the information sources are related to the propensity to innovate with the following equation:

$$\begin{aligned} y_{i,t} = {} & \alpha_0 + \beta_{11}\, internal_{i,t} + \beta_{12}\, suppliers_{i,t} + \beta_{13}\, customers_{i,t} + \ldots \\ & \ldots + \beta_{14}\, competitors_{i,t} + \beta_{15}\, consultants + \beta_{16}\, HEI_{i,t} + \beta_{17}\, conferences_{i,t} + \ldots \\ & \ldots + \beta_{18}\, journals_{i,t} + \beta_{19}\, associations_{i,t} + \beta_{20}\, internet_{i,t} + \alpha_{11} X_{1i,t} + \ldots \\ & \ldots + \alpha_{12} X_{2i,t-1} + \gamma_t + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where $y_{i,t}$ corresponds to a dummy variable identifying if the firm has developed a particular type of innovation (product, process, marketing, organisational and social) or they expect to develop them. X_1 and X_2 are two sets of independent variables, α_i and β_i are the coefficients, γ_t is a temporal dummy, and $\varepsilon_{i,t}$ is the usual error term of firm i at time t. Finally, α_i are the time-invariant unobserved individual effects. The dependent variables correspond to the development and

TABLE 3 Analysis of types of innovation developed and the expectation of future innovation.

	Expectation to innovate in the future %				
Types of innovation already developed	**Social**	**Product**	**Market**	**Organisational**	**Process**
Social	80.2	89.0	69.2	74.7	84.6
Product	31.9	83.5	52.5	56.3	75.2
Market	38.6	79.6	69.9	63.6	78.2
Organisational	36.1	74.7	55.1	65.6	76.6
Process	31.6	71.4	49.0	56.6	75.4

Source: Compiled by the authors from Chilean Innovation Survey data.

TABLE 4 Percentage of firms using information sources based on the type of innovation and its expectation.

	Innovations					Expected innovations				
	Product	**Process**	**Market**	**Organisational**	**Social**	**Product**	**Process**	**Market**	**Organisational**	**Social**
Internal	69	66	61	61	79	38	36	35	34	38
Supplier	43	44	40	39	51	24	23	23	22	26
Client	49	42	47	42	49	26	24	26	22	26
Competition	26	24	28	23	25	14	13	14	13	16
Consultant	23	21	23	23	43	13	12	12	11	15
Government	9	10	10	11	21	6	6	6	6	9
Conference	31	29	32	30	46	18	17	18	16	21
HEI	17	16	16	17	35	9	9	8	8	12
Journals	25	23	23	22	42	14	13	14	12	17
Association	16	17	17	15	27	9	9	9	8	12
Internet	46	43	47	41	55	27	25	26	24	28

Source: Compiled by the authors from Chilean Innovation Survey data.

expectations of innovating in product (*PD*), process (*PC*), marketing (*MARK*), organisational (*ORG*) and social (*SOC*). Additionally, our key variables are the types of information sources used by firms (*internal*, *suppliers*, *customers*, *competitors*, *consultants*, *HEI*, *conferences*, *journals*, *associations and Internet*). However, there are variables related to firms' characteristics such as sales, spending on R&D, the firm age, exports, the type of firm, cooperation, workers, among others, and finally, the government support variables such as being awarded a tax incentive for R&D and the application and allocation of public funds.

Finally, we must clarify that the dataset is cross-sectional. Some variables have lags because the survey collects information corresponding to the current year and the previous year (sales, or costs or percentage of professionals, among others). Whenever it is possible, we have included them in lags in order to mitigate certain correlation between independent and dependent variables.

4 | RESULTS

The following section identifies the variables that significantly influence the development of different types of technological and non-technological innovations. Next, we develop a second model which seeks to identify relevant variables for the development of future innovations.

4.1 | The influence of information sources on innovation

Table 5 shows our main results. First, we must remark that the coefficient of internal sources of information has significant and positive values for all types of innovation. This result matches those of Bach et al. (2015) and Llopis (2018) who find that the internal sources, market, and other information sources are the most important for developing innovations of Spanish manufacturing and service firms. Furthermore, Amara and Landry (2005) indicate that the higher the degree of novelty of the innovations introduced by firms, the more likely they are to use a wide diversity of internal sources. Similarly, Leiponen (2001) shows that combining internal and external information results in more radical service innovations.

Second, the sources of information from suppliers, customers and the Internet show a positive coefficient in all types of innovations, except for social innovations. This result resembles Oerlemans et al. (2001) who identify that buyers and suppliers have stronger effects on

TABLE 5 Multivariate Probit of the probabilities of innovating.

	PD		PC		MARK		ORG		SOC	
Variables	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**
R& D& i										
Natcoop	0.251**	(0.118)	0.265**	(0.118)	0.119	(0.115)	0.172	(0.114)	0.423***	(0.162)
Intercoop	0.309*	(0.165)	−0.212	(0.161)	0.123	(0.154)	0.169	(0.156)	−0.048	(0.194)
Internal RD_1_ln	0.028***	(0.004)	0.006	(0.004)	0.003	(0.004)	−0.002	(0.004)	0.005	(0.007)
External RD_1_ln	0.004	(0.007)	−0.005	(0.007)	0.006	(0.007)	0.001	(0.006)	−0.003	(0.009)
Sources information										
Internal	0.893***	(0.079)	1.183***	(0.075)	0.765***	(0.079)	0.887***	(0.075)	0.681***	(0.149)
Suppliers	0.293***	(0.079)	0.606***	(0.076)	0.174**	(0.079)	0.296***	(0.076)	0.200	(0.129)
Customers	0.440***	(0.084)	0.160*	(0.081)	0.388***	(0.083)	0.264***	(0.081)	0.105	(0.131)
Competitors	0.050	(0.096)	−0.041	(0.093)	0.243***	(0.092)	0.032	(0.092)	−0.152	(0.147)
Consultants	0.058	(0.104)	0.092	(0.101)	0.155	(0.100)	0.265***	(0.098)	0.398***	(0.144)
HEI	−0.007	(0.125)	0.063	(0.121)	−0.089	(0.121)	0.105	(0.119)	0.024	(0.164)
Government	−0.407***	(0.144)	0.009	(0.137)	−0.058	(0.136)	0.065	(0.133)	−0.079	(0.184)
Conferences	0.011	(0.098)	−0.004	(0.096)	0.178*	(0.095)	0.151	(0.094)	0.082	(0.147)
Journals	−0.043	(0.112)	0.014	(0.110)	−0.220**	(0.109)	−0.144	(0.108)	0.229	(0.157)
Associations	−0.028	(0.120)	0.259**	(0.118)	0.007	(0.115)	−0.024	(0.115)	−0.042	(0.165)
Internet	0.189**	(0.086)	0.146*	(0.083)	0.329***	(0.084)	0.206**	(0.083)	0.053	(0.140)
Company characteristics										
Capital	−0.010	(0.114)	0.160	(0.108)	0.051	(0.111)	0.201*	(0.104)	0.287	(0.212)
Age_ln	0.003	(0.041)	−0.064*	(0.037)	−0.042	(0.040)	−0.114***	(0.037)	0.021	(0.076)
Perprofessionals_1	0.001	(0.001)	−0.001	(0.001)	0.001	(0.001)	0.002*	(0.001)	0.003*	(0.002)
Sales_1_ln	0.0267*	(0.016)	0.045***	(0.015)	0.017	(0.015)	0.082***	(0.015)	0.055*	(0.029)
High_tech	0.174*	(0.096)	−0.020	(0.088)	0.044	(0.095)	−0.038	(0.087)	0.047	(0.171)
Low_tech	0.08	(0.082)	0.021	(0.073)	0.007	(0.080)	−0.190***	(0.073)	−0.276	(0.169)
High_techserv	0.178*	(0.096)	−0.132	(0.092)	0.058	(0.094)	−0.038	(0.087)	−0.128	(0.171)
Expo_1	−0.005***	(0.002)	−0.001	(0.001)	0.001	(0.001)	−0.000	(0.001)	0.002	(0.003)
Public instrument										
Public_instrument	0.254**	(0.106)	0.273***	(0.102)	0.213**	(0.103)	0.170*	(0.101)	0.637***	(0.138)
RD_Law	−0.103	(0.192)	−0.479**	(0.189)	−0.225	(0.187)	−0.659***	(0.190)	−0.815***	(0.274)
Constant	−1.823***	(0.305)	−2.000***	(0.284)	−1.758***	(0.292)	−2.478***	(0.286)	−3.808***	(0.513)
Observations	4226									
χ^2	1123.43									

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0 where 1 = PD, 2 = PC, 3 = MARK, 4 = ORG, 5 = SOC.

Note: Temporal dummy is included. Standard errors are in parentheses.

***p < .01, **p < .05, and *p < .1.

innovative performance. Similarly, Prokop and Stejskal (2017) conclude that the sources of information from customers affect the development of innovations. As stated by Von Hippel (2017), the relevance of customers as an information source is that they can generate valuable products or designs by generating 'free innovations' that allow firms to collect and evaluate designs delivered by consumers. This allows them to analyse and identify those with the highest profit potential and apply their investment in innovation to improve these designs and with it the development of innovations. A clear example of the previous concept is the study developed by Demonaco et al. (2020), where clients, in this case patients, jointly develop medical innovations.[2]

Information from consultants has significant and positive values for developing social and organisational innovations. Additionally, conferences are only significant for marketing innovations. These results differ from Caloghirou et al. (2004) who identified trade fairs and conferences as drivers of innovative performance. Also, Bigliardi and Dormio (2009) found that information from universities, conferences and scientific articles are significant sources of information for process innovations.

In short, our analysis allows us to partially confirm Hypothesis (1) since technological and non-technological innovations are particularly influenced by internal sources of information in addition to some external sources. For external information sources, suppliers, customers, and the internet have a positive and significant impact on both technological and non-technological innovations. However, we observe some differences that exist in information sources of competitors and consultants where they were only used to promote the development of non-technological innovations.

4.2 | Other determinants

In line with Griffith et al. (2006), internal spending on R&D is only significant for product innovations, while external spending is not significant for any type of innovation. National cooperation presents significant and positive values for product, process and social innovations, whereas foreign cooperation presents significant values exclusively for product innovations. This is important mainly because, according to Leiponen (2001), learning from a wide source of knowledge and internal and external cooperation is strongly associated with the development of successful innovations. Furthermore, according to Robin and Schubert (2013), cooperating with public research institutions significantly increases the intensity of product innovation at the firm level. Additionally, Santamaría et al. (2009) revealed the importance of collaboration agreements for the development of process innovations, and Radicic et al. (2019) suggest that cooperation increases a firm's innovativeness.

Regarding the determinants of the firms' characteristics, the firm age variable is significant but negative for process and organisational innovations. Hence, younger firms are more prone to introduce these innovations. This is in contrast with previous evidence (Azar & Ciabuschi, 2017; Cassiman et al., 2010; Damijan et al., 2010; Golovko & Valentini, 2011; Love & Roper, 2015); if the firm is an exporter, it presents significant but negative values only for product innovations.

Firm sales show positive and significant values for all types of innovation except marketing innovation. This agrees with studies that link the firm size with greater innovation (Acs & Audretsch, 1987; Álvarez & García, 2012; Rezk et al., 2015; Shefer & Frenkel, 2005). Zemplinerová and Hromádková (2012) suggested that it is mainly linked to resources for financing innovation, lower risks, etc.

Finally, a variable that is significant and positive for all types of innovation is whether the firm requested a public instrument to finance its innovation activities. However, obtaining tax incentives for R&D from the government negatively affects process, organisational and social innovation.

4.3 | Analysis of the determinants of the expectation to innovate

In the following subsection, we aim to study hypotheses (2) and (3) by analysing the drivers of the expectations of developing innovations. Table 6 shows the results for each type of expectation to innovate.

Regarding the link between the expectation to innovate and experience (see hypothesis 2), the results show that innovative firms have higher expectations of innovating in the future. In line with Zafar and Kuchler (2015), we confirm that having experience with previously developed innovations positively influences the expectations of developing each innovation, respectively. Particularly, having generated product innovations is a significant and positive variable for the expectation of product and process innovation. Moreover, having innovated in marketing and organisation are variables that influence the expectation to innovate in all types of innovation. Finally, having developed social innovations has a significant and positive relationship with the expectation of developing social innovations.

Similarly, Geldes et al. (2017) concluded that having developed innovations in product or marketing influences the expectation to innovate in product. Nevertheless, only the development of organisational innovations influences the expectation to innovate in processes. Likewise, Mothe and Nguyen-Thi (2012) suggested that organisational and marketing innovations lead to a greater expectation to introduce products. Moreover, having innovated in processes has a positive influence on the expectation of innovating in processes, organisational and social. Finally, Schmidt and Rammer (2007) identified process innovations as inducing organisational innovations, while product and process innovations induce marketing and organisational innovations.

In conclusion, hypothesis (2) is confirmed since the past innovative performance is positively associated with the expectation of innovating in the future. Therefore, future expectations are greatly affected by the innovative capacity developed. This suggests the importance of cumulative knowledge for fostering future innovation outcomes.

4.4 | Comparative analysis of sources of information and the expectation to innovate

Regarding the internal sources of information, we observe that they positively affect the expectation of products, processes and organisational innovations while the information sources of suppliers affect the expectation of developing product innovations. Finally, the source of customer information positively affects the expectation of product innovations but negatively affects the expectation of organisational innovations.

Conversely, the information sources of higher education institutions negatively affect the expectation of product innovation, while using information sources from the government positively affects the expectation of social innovation. This result is contrary to Tödtling et al. (2009) who indicated that more innovative firms cooperate more often with universities and research organisations. However, the sources of information obtained in conferences positively affect the expectation of innovating in marketing, but the companies using the Internet as a source of information positively affect the expectation of product, marketing and organisational innovation.

TABLE 6 Multivariate Probit of the determinants of expectation to innovate.

	ExpPD		ExpPC		ExpMARK		ExpORG		ExpSOC	
Variables	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**
R& D& i										
PD	0.596***	(0.079)	0.152**	(0.074)	0.084	(0.072)	0.025	(0.070)	−0.004	(0.076)
PC	0.044	(0.071)	0.361***	(0.068)	0.077	(0.067)	0.133**	(0.065)	0.114	(0.072)
MARK	0.412***	(0.078)	0.372***	(0.075)	0.878***	(0.070)	0.294***	(0.069)	0.332***	(0.073)
ORG	0.234***	(0.073)	0.354***	(0.069)	0.195***	(0.067)	0.512***	(0.066)	0.333***	(0.070)
SOC	0.095	(0.191)	0.091	(0.172)	0.148	(0.146)	0.241	(0.150)	1.144***	(0.152)
Natcoop	0.141	(0.134)	−0.091	(0.122)	−0.198*	(0.115)	0.152	(0.113)	0.032	(0.119)
Intercoop	0.177	(0.219)	0.094	(0.187)	0.228	(0.157)	0.027	(0.155)	0.164	(0.157)
Internal RD_1_ln	0.017***	(0.005)	0.005	(0.005)	0.004	(0.004)	−0.001	(0.004)	0.002	(0.004)
External RD_1_ln	−0.003	(0.008)	−0.002	(0.007)	0.004	(0.007)	0.001	(0.006)	−0.001	(0.007)
Sources information										
Internal	0.165*	(0.085)	0.275***	(0.081)	0.031	(0.078)	0.158**	(0.077)	0.016	(0.085)
Suppliers	0.219**	(0.089)	0.083	(0.083)	0.085	(0.079)	0.083	(0.077)	0.063	(0.083)
Customers	0.185**	(0.094)	0.090	(0.088)	0.129	(0.083)	−0.165**	(0.081)	−0.070	(0.088)
Competitors	0.024	(0.110)	−0.047	(0.102)	−0.091	(0.095)	0.053	(0.092)	0.079	(0.097)
Consultants	0.065	(0.117)	0.119	(0.108)	0.020	(0.101)	−0.032	(0.098)	−0.079	(0.105)
HEI	−0.255*	(0.142)	0.093	(0.131)	−0.128	(0.116)	−0.120	(0.115)	0.058	(0.119)
Government	0.096	(0.161)	0.017	(0.147)	0.034	(0.136)	0.085	(0.133)	0.235*	(0.137)
Conferences	0.097	(0.112)	0.001	(0.102)	0.195**	(0.095)	0.148	(0.094)	0.042	(0.099)
Journals	0.056	(0.130)	0.126	(0.119)	0.087	(0.108)	−0.095	(0.107)	0.057	(0.110)
Associations	0.170	(0.143)	0.075	(0.129)	0.011	(0.117)	−0.010	(0.114)	0.147	(0.118)
Internet	0.175*	(0.093)	0.103	(0.087)	0.200**	(0.083)	0.240***	(0.082)	0.110	(0.088)
Company characteristics										
Capital	0.206**	(0.095)	0.194**	(0.091)	0.204**	(0.095)	0.314***	(0.089)	0.289***	(0.106)
Age_ln	−0.100***	(0.030)	−0.077***	(0.029)	−0.067**	(0.030)	−0.114***	(0.029)	−0.019	(0.033)
Perprofessionals_1	0.001	(0.001)	−0.002*	(0.001)	−0.000	(0.001)	−0.001	(0.001)	−0.001	(0.001)
Sales_1_ln	0.032***	(0.012)	0.085***	(0.012)	−0.002	(0.012)	0.062***	(0.012)	0.036***	(0.014)
High_tech	0.197***	(0.072)	0.189***	(0.070)	−0.001	(0.072)	−0.002	(0.069)	−0.233***	(0.082)
Low_tech	0.078	(0.058)	0.279***	(0.056)	−0.010	(0.059)	−0.073	(0.056)	−0.027	(0.065)
High_techserv	0.276***	(0.073)	0.083	(0.071)	−0.012	(0.072)	−0.006	(0.065)	−0.040	(0.080)
Expo_1	0.001	(0.001)	0.001	(0.001)	−0.001	(0.001)	0.000	(0.001)	0.003**	(0.001)
Public instrument										
Public_instrument	0.432***	(0.117)	0.235**	(0.105)	−0.000	(0.098)	0.068	(0.097)	0.191*	(0.103)
RD_Law	−0.217	(0.231)	−0.322	(0.204)	−0.290	(0.196)	−0.290	(0.192)	−0.376*	(0.211)
Constant	−0.863***	(0.263)	−1.765***	(0.251)	−0.670***	(0.244)	−1.378***	(0.240)	−1.842***	(0.271)
Observations	4226									
χ^2	3629									

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0 where 1 = PD, 2 = PC, 3 = MARK, 4 = ORG, 5 = SOC.

Note: Temporal dummy is included. Standard errors are in parentheses.

***$p < .01$, **$p < .05$, and *$p < .1$.

Therefore, our analysis confirms hypothesis (3) since the expectation of developing technological and non-technological innovations depends on both internal and external sources of information. However, our results seem to point out to a less significant direct incidence of information sources on the expected outcome than for the probability of innovating. This may suggest the importance of internal accumulated knowledge for planning future innovations.

4.5 | Other determinants

Contrary to the previous section, national cooperation negatively affects the expectation to innovate in marketing. In line with Beynon et al. (2018), R&D spending positively affects only the expectation of product innovations. One possible explanation is that firms that present strategies linked to innovation tend to be more confident in developing future innovations. Finally, applying for promotion initiatives to innovate positively affects the expectation of innovating in products, processes, and society. Conversely, companies that had access to tax relief have a lower expectation of innovating socially.

Regarding the firms' characteristics, older firms present lower expectations of innovating, except for social innovation, where the variable is not significant. In addition, the firm size positively affects the intention to develop product, process, organisational and social innovations. Therefore, larger firms seem to have a greater propensity to innovate in the future which may be related to a larger capacity of these firms to plan the development of innovations. Finally, being a high-tech firm positively affects the expectation of innovating in products and processes, and negatively affects the expectation of social innovations. This result may be due to the different nature of each sector, which is related to technological innovations.

Analysing the differences that exist between the expectation to carry out technological or non-technological innovations, it can be noted that the sources of information from suppliers and customers are variables that exclusively affect the expectation of developing technological innovations. Furthermore, information from governmental institutions and conferences merely affects expectations to innovate in the non-technological field. Here, we confirm the results of Geldes et al. (2017), who show that the intention to innovate is different for technological and non-technological innovations.

To sum up, the sources of internal information and the Internet affect most types of innovations, both in the current probability and the expectation of innovation. Furthermore, suppliers and customers are a significant source of information on the probability of innovating and the expectation to innovate in products. We find a similar result for the information from conferences, which affects both the probability and the expectation of innovating in marketing.

TABLE 7 Multivariate Probit of the probability to innovate.

	PD		PC		MARK		ORG		SOC	
Variables	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**	**Coef**	**Desv.**
R& D & i										
Natcoop	0.240**	(0.113)	0.264**	(0.112)	0.095	(0.111)	0.192*	(0.109)	0.414***	(0.153)
Intercoop	0.129	(0.159)	−0.365**	(0.157)	−0.035	(0.151)	0.053	(0.153)	−0.083	(0.191)
Internal RD_1_ln	0.034***	(0.004)	0.016***	(0.004)	0.011***	(0.004)	0.006	(0.004)	0.012*	(0.006)
External RD_1_ln	0.000	(0.006)	−0.004	(0.006)	0.003	(0.006)	0.002	(0.006)	−0.002	(0.009)
Sources information										
Diversity	0.211***	(0.013)	0.280***	(0.013)	0.232***	(0.012)	0.234***	(0.012)	0.163***	(0.021)
Company characteristics										
Capital	−0.057	(0.109)	0.154	(0.104)	0.006	(0.108)	0.188*	(0.102)	0.310	(0.210)
Age_ln	−0.013	(0.040)	−0.061*	(0.036)	−0.056	(0.039)	−0.120***	(0.036)	0.019	(0.074)
Perprofessionals_1	0.000	(0.001)	−0.001	(0.001)	0.001	(0.001)	0.002*	(0.001)	0.004*	(0.002)
Sales_1_ln	0.040***	(0.015)	0.065***	(0.014)	0.027*	(0.014)	0.095***	(0.014)	0.066**	(0.028)
High_tech	0.202**	(0.092)	−0.001	(0.085)	0.066	(0.092)	−0.019	(0.085)	0.080	(0.167)
Low_tech	0.098	(0.079)	0.046	(0.070)	0.028	(0.077)	−0.165**	(0.071)	−0.247	(0.165)
High_techserv	0.150	(0.093)	−0.132	(0.089)	0.048	(0.092)	−0.049	(0.085)	−0.116	(0.167)
Expo_1	−0.005***	(0.002)	−0.000	(0.001)	0.000	(0.001)	−0.000	(0.001)	0.002	(0.002)
Public instrument										
Public_instrument	0.185*	(0.103)	0.226**	(0.098)	0.162	(0.101)	0.176*	(0.098)	0.645***	(0.133)
RD_law	−0.224	(0.190)	−0.641***	(0.187)	−0.353*	(0.184)	−0.769***	(0.187)	−0.756***	(0.266)
Constant	−1.725***	(0.293)	−2.044***	(0.273)	−1.666***	(0.282)	−2.453***	(0.277)	−3.809***	(0.495)
Observations	4226									
χ^2	1297									

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0, where 1 = PD, 2 = PC, 3 = MARK, 4 = ORG, 5 = SOC.

Note: temporal dummy is added. Standard errors are in parentheses.

***$p < .01$, **$p < .05$, and *$p < .1$.

4.6 | Extension analysis: the diversity of sources

To ensure the robustness of our results, it is essential to carry out a comparison of the results obtained in both models. For this purpose, we have introduced new variables in our two original models. Next, we proceed to develop two different models as extensions. First, we generate a new variable to measure the 'diversity' of the information sources, which indicates the number of information sources used by each firm. The variable has a value of 11 when all the sources are used, and it decreases as the number of information sources used diminishes to 0 when no information source is used. The diversity variable is acknowledged by various authors as search breadth, and as (Laursen & Salter, 2006; Luo et al., 2017; Terjesen & Patel, 2017) the use of multiple external information sources facilitates innovation development. Table 7 shows the results for the probability of innovating.

Our proxy of the diversity of information sources shows a significant and positive coefficient, regardless of the type of innovations. This implies that the greater the number of sources of information used, both external and internal, the greater the probability of innovating.

Although compared to the original model in Table 5, few changes are recorded, it is important to highlight some of them. Firstly, it can be noted that internal R&D expenditures have acquired significance, not only in terms of product innovation but also in process, marketing and social innovation. In this model, international cooperation no longer plays a significant role in the development of product innovation.

Furthermore, it is important to note that sales had a significant impact on all types of innovation, except for marketing innovation. However, in the model presented, sales are significant for all types of innovation, including marketing innovation. Finally, it is relevant to

TABLE 8 Multivariate Probit of the determinants of expectation to innovate.

	ExpPD		ExpPC		ExpMARK		ExpORG		ExpSOC	
VARIABLES	Coef	Desv.	Coef	Desv.	Coef	Desv.	Coef	Desv.	Coef	Desv.
R& D & i										
PD	0.621***	(0.078)	0.166**	(0.073)	0.099	(0.070)	0.030	(0.069)	−0.023	(0.074)
PC	0.077	(0.069)	0.396***	(0.067)	0.083	(0.065)	0.169***	(0.063)	0.115*	(0.069)
MARK	0.427***	(0.078)	0.374***	(0.074)	0.876***	(0.069)	0.301***	(0.068)	0.320***	(0.072)
ORG	0.228***	(0.072)	0.359***	(0.069)	0.193***	(0.067)	0.515***	(0.065)	0.324***	(0.070)
SOC	0.051	(0.189)	0.099	(0.171)	0.129	(0.144)	0.214	(0.148)	1.136***	(0.070)
Natcoop	0.069	(0.129)	−0.086	(0.118)	−0.224**	(0.111)	0.117	(0.108)	0.037	(0.070)
Intercoop	0.177	(0.218)	0.074	(0.184)	0.213	(0.154)	−0.012	(0.153)	0.177	(0.070)
Internal_RD_1_ln	0.018***	(0.005)	0.008	(0.005)	0.004	(0.004)	0.000	(0.004)	0.001	(0.070)
External_RD_1_ln	−0.004	(0.008)	−0.001	(0.007)	0.003	(0.007)	0.000	(0.006)	−0.002	(0.070)
Sources information										
Diversity	0.116***	(0.015)	0.090***	(0.014)	0.071***	(0.013)	0.047***	(0.013)	0.051***	(0.014)
Company characteristics										
Capital	0.199**	(0.095)	0.196**	(0.09)	0.209**	(0.095)	0.322***	(0.089)	0.296***	(0.105)
Age_ln	−0.101***	(0.029)	−0.077***	(0.029)	−0.067**	(0.030)	−0.108***	(0.029)	−0.014	(0.033)
Perprofessionals_1	0.000	(0.001)	−0.001*	(0.001)	−0.000	(0.001)	−0.001	(0.001)	−0.001	(0.001)
Sales_1_ln	0.033***	(0.012)	0.086***	(0.012)	−0.004	(0.012)	0.061***	(0.012)	0.034**	(0.014)
High_tech	0.204***	(0.072)	0.193***	(0.070)	0.014	(0.072)	0.001	(0.069)	−0.242***	(0.082)
Low_tech	0.080	(0.058)	0.281***	(0.056)	−0.009	(0.058)	−0.071	(0.056)	−0.030	(0.065)
High_techserv	0.277***	(0.072)	0.083	(0.071)	−0.009	(0.072)	0.005	(0.069)	−0.038	(0.079)
Expo_1	0.001	(0.001)	0.001	(0.001)	−0.000	(0.001)	0.000	(0.001)	0.003**	(0.001)
Public instrument										
Public_instrument	0.387***	(0.114)	0.243**	(0.103)	−0.015	(0.096)	0.061	(0.095)	0.208**	(0.099)
RD_Law	−0.220	(0.232)	−0.310	(0.202)	−0.271	(0.194)	−0.322*	(0.189)	−0.400*	(0.208)
Constant	−0.878***	(0.260)	−1.742***	(0.249)	−0.656***	(0.241)	−1.406***	(0.238)	−1.872***	(0.266)
Observations	4226									
χ^2	3627									

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0, where 1 = PD, 2 = PC, 3 = MARK, 4 = ORG, 5 = SOC.

Note: Temporal dummy is added. Standard errors are in parentheses.

***$p < .01$, **$p < .05$, and *$p < .1$.

highlight that the use of public instruments does not have a significant effect on marketing innovation.

Secondly, Table 8 shows the determinants to expect to innovate in all types of innovation. Our new variable identifying the diversity of sources of innovations is significant and positive for the expectation to innovate in almost all typologies.

The results of this model resemble those of the model in Table 6, although two differences stand out. Initially, process innovation becomes a significant factor in the expectation of developing social innovations in this new model. However, the variable related to R&D legislation shows a negative influence on both the expectation of organisational innovation and the expectation of social innovation.

5 | CONCLUSIONS

Detailed attention has been paid to the factors affecting the development of innovations. However, the sources of information have not been investigated in depth for all types of innovation and especially for social innovation. Information sources are basic to generate knowledge, particularly nowadays when innovations are technologically more complex and the interaction between different agents is necessary. The diversity in the use of information sources is relevant since they allow firms to generate knowledge which is necessary to innovate and even achieve innovations worldwide (Amara & Landry, 2005). This study aims at analysing the role of information sources in the ability of Chilean firms to innovate, as well as their expectations of innovating. Our data source is the Innovation Survey of Chilean companies in the years 2013–2014 and 2015–2016. We develop a multivariate Probit model both for the probability of innovating and for firms' expectations to innovate.

Our main results show that internal information sources, market sources such as suppliers and customers, and the internet affect the development of technological and non-technological innovations. In contrast to the earlier findings of the study, it is emphasised that social innovations primarily rely on information gathered from internal sources within companies as well as from external consultants. Concerning the expectation to innovate, internal information sources and information from the internet play a crucial role. Specifically, these sources are important for the development of the future product, process and organisational innovations. In the case of the expectation of social innovation, the source of information from the government is positive and significant.

Finally, an important result is the generation of innovations from the information offered by clients that impact development in almost all types of innovation except social innovation. We propose that companies start works and initiatives jointly with consumers or clients in accordance with Von Hippel (2017). This flow of information generated in this kind of cooperation seems to be crucial to foster innovations.

Surprisingly, the institutional source of information, coming from higher education institutions and the government, does not influence the development of innovations. Our results suggest that greater links should be promoted. To achieve this, it would be necessary to generate trust between organisations and institutions of higher education and the government. This is in line with claims of previous authors; Cassiman and Veugelers (2006), for example, emphasised the importance of universities and research centres as a source of information for the innovation process. Amara and Landry (2005) and Tödtling et al. (2009) indicated that radical innovations can be fostered by policies that strengthen links among companies, government laboratories and universities, links that are rarely developed by companies in Chile. Similarly, Robin and Schubert (2013) stressed the importance of cooperation between science and business for the economy. Furthermore, Cohen et al. (2002) indicated that public research is not only used to generate new ideas but also to help complete existing R&D projects in organisations.

According to Amara and Landry (2005), when companies use a wider variety of information, they are more likely to develop product or process innovation worldwide. Our outcomes confirm these results for the case of Chile. Consequently, in addition to promoting the use of diverse sources of information to develop innovations, it is fundamental for governments to place greater emphasis in their political efforts on expanding the strategies for linking organisations so that they can work together.

This article contributes to the literature in three ways. First, many studies identify variables that influence the development of innovations but mainly linked to firms' characteristics such as size and age; however, few emphasise the factors linked to the generation of knowledge, such as sources of information. We provide evidence on how the different sources of information affect the probability of innovating and its expectation. Second, instead of focussing exclusively on technological innovations as most studies do, we further cover non-technological innovations, including social innovation. Different typologies of innovations are characterised by the need of different sources of knowledge and modes of innovating. Thus, the exploration of the incidence of the different information sources is basic. Finally, we propose a model that allows identifying the variables that influence a firm's expectation to innovate. The firms that expect to develop an innovation are those that systematically planned their innovative strategy; the importance of internal accumulated knowledge from experience seems crucial.

We find that the different types of innovation depend on diverse sources of information, a result similar to Varis and Littunen (2010). Furthermore, we find that internal information sources contribute to the development of all types of innovation, but regarding the expectation of innovating, it only influences product, process and organisational innovation.

5.1 | Managerial and policy implications

The use of information sources for the development of current and future innovations poses a great challenge for governmental policies. The relationship between the uses of information sources and their effect on innovation is manifest, making it important that public policies adapt to all firm sizes, starting with those information sources

that are free and available to all and encouraging their use. It is crucial to promote innovation development to make it accessible to firm sizes, since, currently, it is mainly large companies that undertake it. However, we propose a restructuration of the R&D law since it is a factor that affects negatively the development of innovations and one of the main initiatives for linking the government, universities, researchers, and private organisations in the development of innovations. The social innovation, despite the limited literature on information sources, holds significant importance for organisations today, impacting both social and environmental realms. Analysing the factors influencing its development and identifying pertinent sources of information for managers becomes paramount. Notably, internal information sources and consultants and utilisation of public financing emerge as pivotal factors driving social innovation. Thus, promoting these aspects is essential to foster its advancement.

As mentioned previously, the proposed restructuring of the law entails that we could consider the following: the law focusses on enhancing research and development in companies through tax incentives. However, currently in Chile, there is not an advanced technological development but rather an acquisition or absorption of technology. However, the integration of highly qualified human capital is weak, as companies still do not commonly consider the incorporation of, for example, doctors. Additionally, this approach primarily targets large companies, as they are the ones that can afford the investments in these aspects. Hence, it is suggested to focus efforts on developing human capital capable of absorbing or generating technology, as well as creating knowledge and establishing links with the industry. This includes the development of networks with universities and research centres, and strengthening development at the level of small and medium-sized enterprises (SMEs).

Finally, it is essential to review current innovation policies and execute innovation strategies for their effective monitoring. It is crucial to focus on specific development funds for social innovation, reform research and development legislation, and promote collaboration between the different organisations of the innovative ecosystem considering that the use of information sources allows the development of current and future innovations.

This approach has important managerial implications by providing managers with the ability to select optimal strategies for the development of innovations. For example, we allow them to evaluate which information sources, such as collaborations with universities or seeking public funding, are most suitable for their specific innovation objectives. In this way, managers can make more informed and effective decisions to drive the growth and competitiveness of their organisations.

The limitations of the study could be the lack of additional explanatory variables and the absence of a longitudinal analysis to track the impact of the innovations developed over time. Based on the results presented in the article, it is suggested for future research to include additional explanatory variables and carry out a longitudinal study to evaluate the impact of innovations over time. Furthermore, it would be beneficial to add information on whether the innovation developed is new for the company or for the market, which could provide interesting results for further analysis.

CONFLICT OF INTEREST STATEMENT

We affirm that there are no conflicts of interest present in this article.

DATA AVAILABILITY STATEMENT

The data is openly accessible and can be found on the website of the Chilean Ministry of Science, https://www.observa.minciencia.gob.cl/datos-abiertos.

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ENDNOTES

[1] Despite the absence of studies at the firm level, we must highlight various works related to managerial behaviour. Kunz and Linder (2015) conclude that an individual's performance or achievement needs can influence their intention to engage in management innovation. According to the self-perception study developed by Román (2020), intellectual factors such as structural and relational capital positively influence the intention to innovate of middle management professionals in an R&D area of a firm. Similarly, Massu et al. (2018) investigate the factors that determine managers' intentions to innovate but from the perspective of the implementation of teleworking. Relevant factors include the attitude and the perception of organisational support, but the most important factor is the attitude towards innovation. Zafar and Kuchler (2015) indicate that people's intentions are influenced by past behaviours, experiences, or decisions. Considering that a firm's behaviour may be the result of its managers, we assume a similar behaviour at firm level. Firms that have already developed an innovation may have higher expectations of innovating in the future.

[2] Furthermore, Amara and Landry (2005) identified that customers are more frequently used as sources of information for firms that have introduced global innovations, whereas Bach et al. (2015) suggested that customers and suppliers are important sources of information for R&D activities. Additionally, Griffith et al. (2006) indicated that suppliers are an important source of information for process innovations. Similarly, Robin and Schubert (2013) concluded that the use of supplier and customer information may be sufficient to generate process, but not product, innovation.

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APPENDIX A

TABLE A1 Mean, standard deviation and correlations.

	Mean	Std.	PD	PC	ORG	MARK	SOC	ExpPD	ExpPC	ExpORG	ExpMARK	ExpSOC	Natcoop	Intercoop	Internal RD_1_ln	External RD_1_ln	Internal	Suppliers
PD	0.10	0.30	1															
PC	0.15	0.36	0.50	1														
ORG	0.14	0.33	0.41	0.51	1													
MARK	0.10	0.31	0.40	0.40	0.50	1												
SOC	0.02	0.13	0.24	0.22	0.23	0.25	1											
ExpPD	0.34	0.47	0.34	0.29	0.30	0.30	0.14	1										
ExpPC	0.35	0.48	0.27	0.32	0.30	0.28	0.12	0.53	1									
ExpORG	0.30	0.46	0.19	0.29	0.29	0.24	0.12	0.42	0.52	1								
ExpMARK	0.25	0.44	0.20	0.21	0.25	0.35	0.13	0.48	0.44	0.51	1							
ExpSOC	0.15	0.36	0.17	0.20	0.23	0.23	0.25	0.38	0.37	0.47	0.45	1						
Natcoop	0.04	0.21	0.33	0.30	0.29	0.26	0.24	0.23	0.19	0.16	0.13	0.18	1					
Intercoop	0.02	0.13	0.29	0.20	0.23	0.21	0.20	0.18	0.14	0.12	0.13	0.16	0.62	1				
Internal RD_1_ln	−12.71	4.62	0.42	0.34	0.29	0.29	0.22	0.29	0.23	0.15	0.17	0.16	0.42	0.41	1			
External RD_1_ln	−13.41	2.82	0.20	0.17	0.17	0.17	0.12	0.14	0.13	0.09	0.10	0.09	0.31	0.27	0.32	1		
Internal	0.15	0.36	0.50	0.56	0.45	0.42	0.22	0.37	0.34	0.24	0.23	0.19	0.42	0.31	0.54	0.28	1	
Suppliers	0.10	0.30	0.37	0.46	0.35	0.32	0.17	0.29	0.26	0.19	0.21	0.17	0.32	0.24	0.35	0.21	0.57	1
Customers	0.09	0.29	0.43	0.42	0.37	0.38	0.17	0.32	0.28	0.18	0.23	0.17	0.38	0.29	0.43	0.23	0.61	0.56
Competitors	0.06	0.24	0.28	0.30	0.26	0.30	0.10	0.22	0.20	0.15	0.16	0.14	0.23	0.18	0.25	0.12	0.45	0.41
Consultants	0.05	0.22	0.27	0.29	0.29	0.26	0.22	0.22	0.20	0.14	0.15	0.15	0.37	0.31	0.35	0.30	0.41	0.37
HEI	0.03	0.18	0.23	0.26	0.25	0.21	0.21	0.18	0.18	0.12	0.11	0.15	0.49	0.34	0.34	0.28	0.35	0.27
Government	0.02	0.15	0.13	0.19	0.19	0.17	0.15	0.15	0.13	0.10	0.10	0.15	0.33	0.26	0.27	0.24	0.26	0.22
Conferences	0.06	0.24	0.32	0.35	0.32	0.32	0.19	0.27	0.23	0.19	0.21	0.18	0.38	0.30	0.38	0.22	0.51	0.46
Journals	0.04	0.21	0.29	0.31	0.26	0.25	0.21	0.24	0.21	0.15	0.18	0.17	0.34	0.31	0.41	0.23	0.44	0.39
Associations	0.03	0.18	0.22	0.28	0.22	0.22	0.16	0.20	0.17	0.12	0.14	0.16	0.33	0.24	0.29	0.20	0.34	0.35
Internet	0.10	0.30	0.38	0.41	0.35	0.37	0.18	0.31	0.26	0.21	0.23	0.18	0.36	0.24	0.44	0.22	0.62	0.54
Capital	0.95	0.22	−0.05	−0.02	−0.02	−0.03	−0.00	−0.02	−0.01	0.02	0.01	0.02	−0.04	−0.06	−0.07	−0.06	−0.07	−0.03
Age_ln	2.58	0.78	0.05	0.03	0.00	0.01	0.05	−0.03	0.02	−0.03	−0.03	0.01	0.05	0.06	0.08	0.04	0.07	0.04
Perprofessionals_1	20.61	28.12	0.07	0.03	0.09	0.07	0.07	0.08	−0.01	0.03	0.03	0.00	0.09	0.06	0.13	0.05	0.11	0.03
Sales_1_ln	14.12	2.24	0.18	0.19	0.18	0.13	0.11	0.13	0.19	0.12	0.05	0.10	0.21	0.21	0.27	0.17	0.26	0.19
High_tech	0.06	0.23	0.05	0.03	0.03	0.03	0.03	0.05	0.04	0.02	0.02	−0.02	−0.00	0.02	0.07	0.02	0.05	0.03
Low_tech	0.15	0.36	−0.01	0.03	−0.05	−0.01	−0.03	−0.03	0.07	−0.02	−0.02	0.02	0.02	0.02	−0.02	0.03	−0.01	0.02
High_techserv	0.05	0.21	0.06	0.01	0.04	0.04	0.02	0.10	0.01	0.03	0.03	0.01	0.06	0.03	0.09	0.02	0.06	0.04
Expo_1	4.51	17.64	0.04	0.07	0.06	0.06	0.05	0.07	0.09	0.03	0.02	0.07	0.10	0.10	0.14	0.10	0.12	0.09
Public_instrument	0.04	0.19	0.22	0.20	0.17	0.17	0.22	0.12	0.15	0.09	0.09	0.12	0.32	0.26	0.32	0.21	0.29	0.16
RD_Law	0.01	0.09	0.15	0.11	0.07	0.10	0.05	0.10	0.07	0.03	0.04	0.04	0.24	0.19	0.27	0.19	0.20	0.11

TABLE A1 (Continued)

	Customers	Competitors	Consultants	HEI	Government	Conferences	Journals	Associations	Internet	Capital	Age_ln	Perprofesionales_1	Sales_1_ln	High_tech	Low_tech	High_techserv	Expo_1	Public_instrument	RD_Law
PD																			
PC																			
ORG																			
MARK																			
SOC																			
ExpPD																			
ExpPC																			
ExpORG																			
ExpMARK																			
ExpSOC																			
Natcoop																			
Intercoop																			
Internal RD_1_ln																			
External RD_1_ln																			
Internal																			
Suppliers																			
Customers	1																		
Competitors	0.53	1																	
Consultants	0.36	0.39	1																
HEI	0.32	0.28	0.46	1															
Government	0.24	0.23	0.39	0.48	1														
Conferences	0.47	0.41	0.44	0.43	0.37	1													
Journals	0.43	0.39	0.43	0.43	0.35	0.59	1												
Associations	0.37	0.36	0.40	0.40	0.37	0.48	0.51	1											
Internet	0.55	0.44	0.42	0.36	0.29	0.56	0.56	0.44	1										
Capital	−0.07	−0.06	−0.04	−0.02	−0.02	−0.04	−0.03	−0.03	−0.02	1									
Age_ln	0.02	0.01	0.02	0.04	0.04	0.05	0.04	0.04	0.02	−0.02	1								
Perprofessionals_1	0.06	0.03	0.08	0.13	0.11	0.09	0.09	0.08	0.09	−0.15	−0.14	1							
Sales_1_ln	0.17	0.13	0.17	0.14	0.10	0.19	0.13	0.13	0.12	−0.27	0.29	0.00	1						
High_tech	0.06	0.02	0.02	0.01	−0.01	0.06	0.06	0.01	0.05	−0.06	0.13	−0.11	0.09	1					
Low_tech	0.00	0.02	0.00	−0.02	−0.01	−0.01	−0.03	0.00	−0.03	0.05	0.20	−0.39	0.13	−0.34	1				
High_techserv	0.03	0.03	0.05	0.06	0.03	0.06	0.06	0.06	0.08	−0.07	−0.19	0.34	−0.09	−0.15	−0.30	1			
Expo_1	0.09	0.06	0.06	0.08	0.07	0.09	0.10	0.09	0.09	−0.19	0.08	0.00	0.27	0.01	0.18	−0.04	1		
Public_instrument	0.24	0.13	0.30	0.32	0.28	0.25	0.25	0.20	0.26	−0.02	0.02	0.12	0.08	0.03	−0.03	0.06	0.08	1	
RD_Law	0.18	0.09	0.24	0.20	0.14	0.23	0.23	0.16	0.19	−0.01	0.06	0.03	0.13	0.06	0.01	−0.01	0.08	0.32	1