Factors explaining firms' receipt of public funding for innovation: the case of Chilean small and medium-sized enterprises*

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Abstract: This study uses innovation surveys conducted in Chile to evaluate the factors that may explain public financing for innovative activities in small and medium-sized firms (SMEs). The analysis is important because small and medium sized firms are the focus of the existing public programs. The estimated results with binary choice models are contrasted with cross-sectional and pseudo-panel data, observing that firms with some types of expenditures on innovative activities in previous year have more probability to obtain public financing.

Keywords: Pseudo-panel; Probit; Public financing.

1. Introduction

Empirical evidence shows that R&D is responsible for growth in productivity. For example, Bravo-Ortega et al. (2014) use cross-sectional data to examine the relation between productivity, expenditure in R&D and exports in Chile, being found that the firms that invest in R&D are more likely to export, R&D improves productivity, and public funding complements private resources for R&D. Álvarez et al. (2010) suggest that in Chile there is no contemporary effect of innovation in products on productivity, though lagged effects are observed after two years. Crespi et al. (2015) use panel data from Colombian firms to demonstrate that the financial incentive programs for R&D have increased labor productivity. Álvarez et al. (2015) point out that in the case of Chile there is an effect of the technological and non-technological innovation on labor productivity in the manufacturing and services sectors. More recently, Crespi et al. (2016) demonstrate that the public funding for innovation is a key factor to facilitate investment in innovation in manufacturing firms of Latin America.

R&D expenditure as a percentage of GDP is low in Chile (0.4%) compared to OECD countries (2.4%). Moreover, Cabaleiro & Salce (2018) conclude that the markets for technology in Chile are not developed. These facts could be explained by uncertain returns from investing in innovation and R&D which affect the conditions for financing this type of activities. For this reason, in recent years the Chilean State has played a more active role in innovation[1] through the creation of diverse programs to mitigate the different obstacles and constraints faced by innovative activities in small and medium-sized firms.

The decision to allocate resources to R&D activities is influenced by the characteristics of the firm, the market and the public incentives. According to Shefer & Frenkel (2005) a 50% of the variation in R&D expenditure is explained by innovation, economic sector, total sales, export orientation and age of the firm. Barge-Gil & López (2014) point out that the evidence is mixed for the effects of financial constraints and public funding instruments on R&D expenditure. González & Pazó (2008) conclude that public funding fosters the private technological effort of small firms. Clausen (2009) shows that research subsidies stimulate R&D expenditure, while development subsidies replace that expenditure. Cerulli & Potí (2012) find a relationship between R&D expenditure and variables such as the number of employees, percentage of employees with university degree, percentage of sales from exports, capital per employee, cash flow per employee, percentage of liabilities, IPR value when the firm belongs to a foreign group, age and geographical location.

According to the international literature, the factors that affect the probability of obtaining public financing for innovation are varied. Huergo *et al.* (2016) indicate that the probability of participating in an R&D loan system increases when a firm has technological profile and sectoral financial constraints. Afcha (2012) demonstrates that the probability of obtaining an R&D subsidy is increased by cooperation networks, recruitment of newly graduated professionals, R&D expenditures from previous years, number of employees and exports. Duch-Brown *et al.* (2011) indicate that having prior experience in R&D projects increases the intensity of subsidies. Cantner & Kösters (2012) demonstrate that the work team and the initial capital of the firm affect the obtaining of public funds.

Previous studies in Chile have focused mainly on the relationship between firms' productivity and innovative variables (Benavente, 2005; Álvarez *et al.*, 2010) and recently on the impact of knowledge obstacles to introduce innovations (Canales & Álvarez, 2017) but have not analyzed what factors influence the probability of obtaining public financing. Therefore, this study seeks to determine the factors that affect the receipt of public support for innovation in small and medium-sized firms, considering cross-sectional data from the different versions of the Innovation Surveys. Then, these results are contrasted with those obtained from a pseudo-panel methodology that uses the cross-sectional databases together.

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(1) Moya & Molina (2017) show that both innovation and entrepreneurship are important concepts in the policies promoted by the government of Chile.

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2. Methodology

2.1 Data

The Innovation Survey of Chilean firms have been collected in nine different versions, the first in 1995 and the last in 2014. Figure 1 shows the number of firms surveyed in each version of the survey. From the first to the fourth survey, the number of firms fluctuates between 520 and 900, while this number grows by over 5600 in the most recent survey. However, in the last five surveys only 55% of firms are SMEs.

Figure 1. Number of firms surveyed in each version of the Innovation Survey
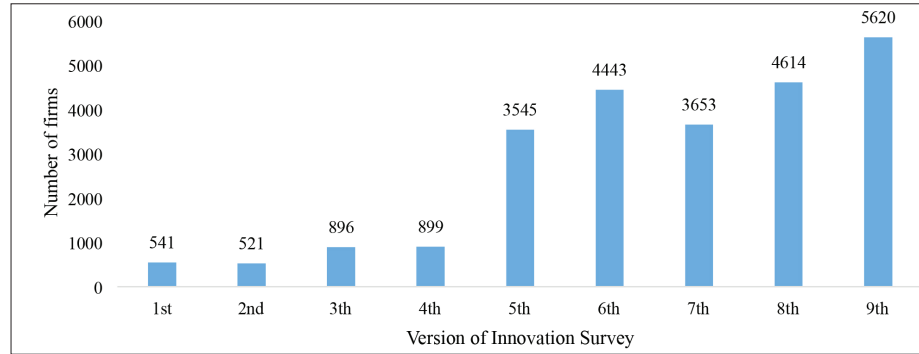
Source: Own elaboration based on data from the 1st to 9th Innovation Surveys

The nine versions of this survey have different structures and variables due to changes in its design but there is greater uniformity starting with the fifth version. Table 1 exemplifies this situation with an extract of some variables that are present in the different versions of the survey.

Therefore, firm-level observations from the fifth to the ninth version of the survey were consolidated into a single database to enable statistical analysis based on cross-sectional estimates and to facilitate a comparison of the results with the pseudo-panel methodology.

Table 1. Extract list of variables database from Innovation Survey

Id	Variable	Codification	Domain	1st Survey	2nd Survey	3th Survey	4th Survey	5th Survey	6th Survey	7th Survey	8th Survey	9th Survey
	Chracteristic of the firm											
P020	**Number of the stablishment owned by the firm.**		Numeric	×	×	×	×	×	P	P	P	×
P021	**If the firm is part of a holding**	Yes = 1; No=0	Numeric (binary)	×	×	×	×	×	P	P	P	P
P024	**Production start year**		Numeric (year)	×	×	×	×	×	P	P	P	P
P025	**Property characteristic**		Numeric	×	×	×	×	P	P	P	P	P
	Private	1										
	Foreign private	2										
	Mix	3										
	Governmental	4										
	Sales, exports and employment											
P201	**Sales year T (more exports)**		Numeric (thousand of pesos)	×	×	P	P	P	P	P	P	P
P203	**Exports year T (FOB value)**		Numeric (thousand of pesos)	×	×	×	P	P	P	P	P	P
P225	**Total number of workers year T (contracted, fees and subcontractors)**		Numeric	×	×	×	P	P	P	P	P	P
	Product innovation											
P3021	**Total percentage of innovative sales (excluding marginally modified ones) over total sales year T**		Numeric (percentage)	×	×	×	×	P	P	P	P	P
	Innovative activities, spending and HR											
P3052	**If the firm has a formal unit, department or R&D laboratory**	Yes = 1; No=0	Numeric (binary)	P	P	P	P	P	P	P	P	P
P3054	**If the firm performed R&D in their own company**	Yes= 1; No=0	Numeric (binary)	×	×	×	P	P	P	P	P	P
P3344	**Percentage share of R&D expenditure incurred by the firm itself in relation to its sales in year T**		Numeric (percentage)	×	×	P	P	P	×	P	P	P
P3056	**If the firm performed R&D outside the company**	Yes= 1; No=0	Numeric (binary)	×	×	×	P	P	P	P	P	P
	Public funding for innovation											
P3275	**If the firm used any of these financing in the years T-1 and T**	Yes = 1; No=0	Numeric (binary)	P	×	×	P	P	P	P	P	P
P3099	**Public external resources used to finance innovative activities**		Numeric (percentage)	P	P	P	P	P	P	×	×	×
P3101	**Private external resources used to finance innovative activities**		Numeric (percentage)	P	P	P	P	P	P	×	×	×
	Intellectual Property Rights											
P3217	**Number of intellectual property rights owned by the firm**		Numeric	×	P	P	P	P	P	P	P	×
P3218	**Total number of intellectual property rights requested by the firm**		Numeric	×	P	P	P	P	P	P	P	P
P3219	**Number of Know-How agreements in force in the firm**		Numeric	×	P	P	P	P	P	P	P	×

Source: Own elaboration from data obtained from 1st to 9th Innovation Surveys.

2.2 Pseudo-panel data

A typical panel data regression can be represented as:

$$y_{it} = \alpha_i + x'_{it}\beta + u_{it}; \quad i = 1, \dots, N; \quad t = 1, \dots, T \tag{1}$$

$$u_{it} = \mu_i + v_{it} \tag{2}$$

Where subscript i indicates the cross-sectional dimension that can denote, for example, individuals, families, firms, and countries, and t indicates the time. In this model, y_{it} it is the dependent variable and x_{it} it is a vector of K explanatory variables. In addition, most panel data applications use a model with two error components, μ_i denoting the individual non-observable effect and v_{it} denoting the remaining disturbance.

Although in many developing countries there is little availability of panel data, it is possible to have repeated cross-sectional data in which the same individuals are not tracked over time. Under this focus, individuals share some common characteristics (in this study, firms belonging to the same economic sector), whereby they can be grouped into cohorts and the averages within the cohorts are treated as observations in a pseudo-panel.

Deaton (1985) suggests the use of cohorts to obtain consistent estimators for β in (1), even if the individual effects α_i are correlated with explanatory variables. By defining C cohorts in which each individual is a member of a single cohort for all periods, all the observations are grouped at the cohort level, so the resulting model can be written as:

$$\bar{y}_{ct} = \bar{x}'_{ct}\beta + \bar{\alpha}_{ct} + \bar{u}_{ct}; \quad c = 1, \dots, C; \ t = 1, \dots, T \tag{3}$$

Where $\bar{y}_{ct}$ is the average value of all y_{it} in cohort c at time t. This is analogously the case for the other variables in the model. The resulting dataset is a pseudo-panel with repeated observations over T periods and C cohorts.

Subsequently, Moffitt (1993) proposes estimating pseudo-panel data through instrumental variables. The interpretation of instrumental variables is useful because it illustrates that alternative estimators can be constructed using other sets of instruments.

2.3 Binary models

Binary choice models such as *probit* or *logit* are widely known and used in empirical applications with cross-sectional data, whereas with data panel the models typically used are *probit* random effects and *logit* fixed effects. However, binary choice models can also be estimated with pseudo-panels data (Verbeek & Vella, 2005; Verbeek, 2008). Specifically, the binary choice model using pseudo-panel data with instrumental variables proposed by Moffitt (1993) can be written as:

$$y^*_{it} = x'_{it}\beta + \alpha_i + u_{it}, \tag{4}$$

$$y_{it} = \begin{cases} 1, & if \ y^*_{it} \geq 0, \\ 0, & in \ other \ case \end{cases} \tag{5}$$

In this case, the dependent variable y^*_{it} is not observed, but the binary variable y_{it} is observed and defined by $y_{it} = 1$ (if $y^*_{it} > 0$) or 0 otherwise. This approach uses dummy variables from the cohorts as instruments for the explanatory variables. Specifically, each individual effect α_i is decomposed into a cohort effect α_c and the deviation of individual i from this effect. It could be defined as $(c = 1, \dots, C)$ if individual i is a member of cohort C, and as 0 otherwise. Thus, α_i can be rewritten as:

$$\alpha_i = \sum_{c=1}^{c} \alpha_c z_{ci} + \varepsilon_i \tag{6}$$

Defining $\alpha = (\alpha_1, \dots, \alpha_c)'$ and $z_i = (z_{1i}, \dots, z_{ci})'$, and then substituting (6) into (4) produces the following:

$$y^*_{it} = x'_{it}\beta + z'_i\alpha + \varepsilon_i + u_{it}; \quad t = 1, \dots, T \tag{7}$$

The next step is to choose the dummy cohort variables in z_i, interacted in time as instruments, in which case linear predictors are:

$$x_{k,it} = z'_i\delta_{kt} + w_{k,it}; \quad k = 1, \dots, K; t = 1, \dots, T \tag{8}$$

Where δ_{kt} is a vector of unknown parameters. The linear predictor for x_{it} is given by $\hat{x}_{it} = \bar{x}_{ct}$, the vector of means in cohort c in period t. In addition, if it is assumed that $\varepsilon_i + u_{it}$ has a normal distribution and that the instruments for x_{it} are not correlated with $\varepsilon_i + u_{it}$. Under these assumptions, the instrumental variable estimator produces a consistent estimator for β and α_c.

3. Results

The study seeks to evaluate whether a firm's innovative actions carried out in the previous year, as well as other characteristics, affect the probability of receiving public support in the current period. This information is relevant for small and medium-sized firms because they may wish to alter their decisions before applying for these types of funds to increase their chances of obtaining them.

To determine the robustness of the results, several specifications of the empirical model are included. Model 1 only includes, as explanatory variables, expenditures on innovative actions carried out in the previous period. Model 2 controls by total sales, number of workers and whether the firm had exports in the previous period; Model 3 also controls by economic sector; Model 4 also adds a control by region of the firm's location; Model 5 controls by size of the firm and model 6 by type of ownership.

Table 2, Table 3, Table 4, Table 5 and Table 6 present the results obtained from *probit* models that estimate the probability of obtaining public financing using cross-sectional data from the fifth to the ninth version of the Survey of Innovation, respectively.

Table 2 shows that the expenditure on external knowledge in previous year and exports in previous year have a positive, significant and robust effect on the probability of obtaining public financing. On the other hand, there is a positive, significant and robust effect between specifications for firms located in the Antofagasta Region, Coquimbo Region, Valparaíso Region, O'Higgins Region, Bío Bío Region, Los Lagos Region and Metropolitan Region. However, there is also a significant, robust and negative effect for the firms have private and foreign property.

Table 2. Results with data from the fifth innovation survey

	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
	Coef.	St. Error		Coef.	St. Error		Coef.	St. Error		Coef.	St. Error		Coef.	St. Error		Coef.	St. Error	
Expenditure on equipment for innovation in t -1	4.2E-07	8.9E-07		5.7E-07	9E-07		1E-06	9.3E-07		1.2E-06	9.2E-07		1.1E-06	9.3E-07		1.2E-06	9.3E-07	
Expenditure on external knowledge in t -1	8.4E-06	2.7E-06	**	8.1E-06	2.8E-06	**	7.1E-06	2.6E-06	**	7.1E-06	2.7E-06	**	6.9E-06	2.6E-06	**	8.4E-06	3E-06	**
Expenditure on training for innovation in t -1	4.5E-06	3.8E-06		4.4E-06	4E-06		2.4E-06	4.1E-06		2.8E-06	4.4E-06		3.2E-06	4.4E-06		3.1E-06	4.6E-06	
Expense on introd. of innovations to the market t -1	3.8E-06	2.4E-06		3.7E-06	2.5E-06		4.8E-06	2.6E-06		3.5E-06	2.8E-06		3.5E-06	2.8E-06		3.7E-06	2.8E-06	
Expenditure on other innovation activities in t -1	4.8E-06	2.8E-06		3.8E-06	2.7E-06		3E-06	2.8E-06		2.1E-06	3E-06		1.7E-06	3.1E-06		9.2E-07	3.2E-06	
No. of Intellectual property rights in t -1	0.00188	0.00589		-0.0003	0.00602		0.00054	0.00615		-0.0003	0.00701		0.00025	0.00693		-0.0008	0.00718	
Total sales in t -1				3.9E-09	6.1E-09		4.4E-09	8.9E-09		9.6E-09	4.6E-08		3.9E-09	5.4E-09		3.9E-09	5.6E-09	
Number of workers in t -1				-0.0002	0.00069		-0.0006	0.00085		-0.0002	0.00083		-0.0005	0.00091		-0.0008	0.00094	
Exports in t -1				0.75	0.125	**	0.69	0.133	**	0.62	0.142	**	0.578	0.143	**	0.596	0.144	**
Agricultural and forestry sector							3.424	138.2		5.359	1933.4		4.239	102.6		4.634	132.1	
Fishing sector							3.175	138.2		5.261	1933.4		4.123	102.6		4.524	132.1	
Mining sector							3.675	138.2		4.881	1933.4		3.672	102.6		4.099	132.1	
Manufacturing sector							2.713	138.2		3.832	1933.4		2.657	102.6		3.025	132.1	
Electricity, gas and water sector							2.961	138.2		4.241	1933.4		3.057	102.6		3.373	132.1	
Construction sector							2.596	138.2		4.685	1933.4		3.515	102.6		3.89	132.1	
Commerce sector							3.269	138.2		4.408	1933.4		3.234	102.6		3.613	132.1	
Transport sector							2.412	138.2		4.475	1933.4		3.339	102.6		3.707	132.1	
Financial Services sector							2.705	138.2		4.904	1933.4		3.746	102.6		4.112	132.1	
Real estate sector							3.458	138.2		5.415	1933.4		4.268	102.6		4.619	132.1	
Social and health services sector							2.487	138.2		4.657	1933.4		3.54	102.6		3.895	132.1	
Other sectors							2.688	138.2		4.682	1933.4		3.542	102.6		3.89	132.1	
Tarapacá Region										0.835	0.49		0.835	0.5		0.828	0.502	
Antofagasta Region										0.98	0.463	*	0.965	0.468	*	0.953	0.469	*
Atacama Region										0.772	0.68		0.791	0.692		0.52	0.737	
Coquimbo Region										1.17	0.384	**	1.157	0.386	**	1.099	0.389	**
Valparaíso Region										1.168	0.288	**	1.199	0.289	**	1.179	0.29	**
O'Higgins Region										1.461	0.363	**	1.5	0.362	**	1.49	0.363	**
Maule Region										.	.		.	.		.	.	
Bío Bío Region										1.256	0.297	**	1.289	0.299	**	1.296	0.3	**
Araucania Region										.	.		.	.		.	.	
Los Lagos Region										1.195	0.303	**	1.175	0.305	**	1.171	0.307	**
Aysén Region										.	.		.	.		.	.	
Magallanes Region										.	.		.	.		.	.	
Metropolitan Region										1.176	0.197	*	1.184	0.197	**	1.171	0.199	**
Los Rios Region										.	.		.	.		.	.	
Small firm													-0.219	0.122		-0.24	0.124	
Private property																-1.22	0.558	*
Foreign Property																-1.918	0.768	*
Mixed Property																-0.916	0.672	
Constant	-1.762	0.0513	**	-1.892	0.0631	**	-4.823	138.2		-7.041	1933.4		-5.757	102.6		-4.89	132.1	
Observations	2048			2048			2048			1909			1909			1909		
Pseudo R2	0.036			0.09			0.157			0.215			0.219			0.229		

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%.

Table 3 shows that the expenditure on external knowledge, expenditure on introduction of innovations to the market, and exports in previous year have a positive, significant and robust effect on the probability of obtaining public financing. At sectoral level, it is observed that the real state sector has a positive, significant and robust effect.

Table 3. Results with data from the sixth innovation survey

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error
Expenditure on equipment for innovation in t -1	1.2E-06	5.4E-07 *	1.2E-06	5.4E-07 *	1.3E-06	5.7E-07 *	1.3E-06	6.1E-07 *	1.3E-06	6.1E-07 *	1.3E-06	6.2E-07 *
Expenditure on external knowledge in t -1	-5E-05	9E-05	-7E-05	9.9E-05	-6E-05	0.00011	-6E-05	0.00011	-6E-05	0.00011	-6E-05	0.00011
Expenditure on training for innovation in t -1	1.7E-05	1.5E-05	1.8E-05	1.5E-05	2.1E-05	1.5E-05	2.4E-05	1.5E-05	2.4E-05	1.5E-05	2.4E-05	1.5E-05
Expense on introd. of innovations to the market t -1	1.9E-05	7.8E-06 *	1.8E-05	8.1E-06 *	1.8E-05	8.1E-06 *	2E-05	8.3E-06 *	2E-05	8.3E-06 *	2E-05	8.2E-06 *
Expenditure on other innovation activities in t -1	2.9E-06	1.4E-06 *	2.7E-06	1.3E-06 *	2.5E-06	1.3E-06 *	2.2E-06	1.2E-06	2.2E-06	1.2E-06	2.3E-06	1.2E-06
No. of Intellectual property rights in t -1	0.249	0.231	0.224	0.236	0.147	0.257	0.16	0.268	0.157	0.267	0.16	0.267
Total sales in t -1			-4E-08	6.4E-08	-4E-08	6.5E-08	-4E-08	6.7E-08	-6E-08	8.3E-08	-6E-08	8.4E-08
Number of workers in t -1			3.7E-05	0.00028	-4E-05	0.0003	-8E-05	0.00032	-9E-05	0.00033	-9E-05	0.00033
Exports in t -1			0.436	0.156 **	0.443	0.164 **	0.43	0.173 *	0.419	0.175 *	0.408	0.175 *
Agricultural and forestry sector					0.667	0.346	0.575	0.363	0.576	0.362	0.573	0.362
Fishing sector					.		.		.		.	
Mining sector					.		.		.		.	
Manufacturing sector					0.273	0.315	0.342	0.331	0.352	0.331	0.353	0.331
Electricity, gas and water sector					.		.		.		.	
Construction sector					0.282	0.371	0.255	0.39	0.254	0.39	0.254	0.389
Commerce sector					-0.0276	0.38	-0.0465	0.396	-0.0406	0.395	-0.0457	0.395
Transport sector					-0.28	0.392	-0.206	0.404	-0.207	0.404	-0.229	0.408
Financial Services sector					0.0794	0.491	0.239	0.503	0.24	0.503	0.214	0.505
Real estate sector					0.679	0.322 *	0.808	0.34 *	0.815	0.34 *	0.812	0.34 *
Social and health services sector					.		.		.		.	
Other sectors					0.0514	0.51	0.162	0.517	0.168	0.517	0.17	0.516
Tarapacá Region					.		.		.		.	
Antofagasta Region					.		.		.		.	
Atacama Region							-0.0237	0.429	-0.0283	0.431	-0.0276	0.431
Coquimbo Region							-0.267	0.487	-0.275	0.486	-0.273	0.487
Valparaíso Region							0.0866	0.331	0.081	0.332	0.0774	0.333
O'Higgins Region							-0.232	0.414	-0.237	0.414	-0.239	0.415
Maule Region							0.00068	0.348	-0.0024	0.349	-0.0044	0.35
Bío Bío Region							-0.215	0.355	-0.219	0.356	-0.221	0.357
Araucania Region							-0.0436	0.368	-0.0496	0.369	-0.0549	0.369
Los Lagos Region							-0.437	0.415	-0.445	0.417	-0.454	0.417
Aysén Region							-0.0039	0.559	-0.0038	0.561	-0.0011	0.561
Magallanes Region							0.0229	0.396	0.019	0.397	0.0223	0.397
Metropolitan Region							-0.476	0.299	-0.48	0.3	-0.489	0.3
Los Rios Region							0.208	0.355	0.203	0.357	0.187	0.358
Small firm									-0.0682	0.146	-0.0655	0.146
Private property											3.11	274.5
Foreign Property											3.282	274.5
Mixed Property											3.339	274.5
Constant	-2.002	0.0567 **	-2.022	0.0773 **	-2.291	0.304 **	-2.102	0.411 **	-2.054	0.424 **	-5.163	274.5
Observations	2440		2440		2277		2156		2156		2156	
Pseudo R2	0.042		0.054		0.099		0.125		0.125		0.126	

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%.

Table 4 shows that there are no statistically significant and robust effects of expenditures on innovative activities carried out in the previous year on the probability of obtaining public support. However, there is also a significant, robust and negative effect for small sized and private property firms.

Table 4. Results with data from the seventh innovation survey

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error
Expenditure on equipment for innovation in t -1	1.3E-07	2.1E-07	1.3E-07	2.1E-07	1E-07	2.1E-07	8.5E-08	2.1E-07	6.6E-08	2.2E-07	7E-08	2.2E-07
Expenditure on external knowledge in t -1	-4E-06	1.9E-05	-6E-06	1.9E-05	-6E-06	1.8E-05	-7E-06	1.8E-05	-7E-06	1.8E-05	-6E-06	1.7E-05
Expenditure on training for innovation in t -1	6.2E-05	3.2E-05	6.2E-05	3.2E-05	0.00007	3.6E-05	6.4E-05	3.5E-05	0.00006	3.4E-05	6.2E-05	3.5E-05
Expense on introd. of innovations to the market t -1	3.2E-06	3.5E-06	2.5E-06	3.6E-06	2.3E-06	3.7E-06	2.2E-06	3.8E-06	2.3E-06	3.8E-06	2.3E-06	3.9E-06
Expenditure on other innovation activities in t -1	6.4E-07	9E-06	1.4E-07	9.3E-06	-4E-07	9.8E-06	8.9E-07	9.6E-06	-6E-07	9.9E-06	-4E-07	0.00001
No. of Intellectual property rights in t -1	0.0217	0.082	0.0281	0.0818	0.0312	0.082	0.0386	0.0825	0.0384	0.0833	0.00286	0.0884
Total sales in t -1			7.3E-08	5.2E-08	8.5E-08	5.5E-08	7.8E-08	5.7E-08	-1E-08	7.8E-08	-2E-08	8E-08
Number of workers in t -1			-7E-05	0.00028	-0.0001	0.00031	-5E-05	0.00032	-0.0002	0.00035	-0.0002	0.00035
Exports in t -1			0.297	0.172	0.237	0.176	0.256	0.182	0.254	0.182	0.247	0.183
Agricultural and forestry sector					0.215	0.246	0.168	0.254	0.15	0.256	0.105	0.259
Fishing sector					0.2	0.296	0.105	0.311	0.116	0.31	0.101	0.311
Mining sector					.		.		.		.	
Manufacturing sector					-0.0248	0.207	-0.0031	0.215	-0.0193	0.216	-0.0264	0.217
Electricity, gas and water sector					-0.118	0.535	-0.059	0.539	-0.154	0.544	-0.198	0.544
Construction sector					0.0657	0.261	0.00998	0.269	-0.0012	0.271	-0.0096	0.271
Commerce sector					-0.216	0.259	-0.242	0.265	-0.27	0.267	-0.289	0.268
Transport sector					-0.294	0.267	-0.319	0.272	-0.341	0.275	-0.38	0.278
Financial Services sector					.		.		.		.	
Real estate sector					0.0652	0.227	0.0718	0.234	0.0665	0.235	0.0305	0.237
Social and health services sector					-0.547	0.357	-0.539	0.364	-0.539	0.364	-0.559	0.366
Other sectors					-0.14	0.322	-0.17	0.338	-0.194	0.341	-0.197	0.341
Tarapacá Region							0.298	0.361	0.327	0.365	0.356	0.367
Antofagasta Region							0.265	0.36	0.242	0.365	0.266	0.366
Atacama Region							0.125	0.366	0.12	0.368	0.113	0.373
Coquimbo Region							-0.191	0.409	-0.203	0.415	-0.172	0.416
Valparaíso Region							0.0802	0.336	0.0931	0.34	0.121	0.341
O'Higgins Region							-0.0754	0.358	-0.0689	0.364	-0.0354	0.365
Maule Region							-0.352	0.397	-0.382	0.405	-0.373	0.407
Bío Bío Region							0.12	0.322	0.129	0.325	0.139	0.328
Araucania Region							0.273	0.324	0.277	0.328	0.302	0.33
Los Lagos Region							0.362	0.336	0.352	0.34	0.358	0.342
Aysén Region							0.36	0.375	0.347	0.381	0.324	0.386
Magallanes Region							0.0535	0.364	0.069	0.368	0.0784	0.369
Metropolitan Region							-0.144	0.297	-0.153	0.301	-0.172	0.303
Los Rios Region							0.343	0.338	0.344	0.344	0.349	0.346
Small firm									-0.327	0.131 *	-0.341	0.133 *
Private property											-1.642	0.801 *
Foreign Property											-0.864	0.89
Mixed Property											-1.369	0.969
Constant	-1.699	0.0516 **	-1.774	0.0666 **	-1.709*	0.188 *	-1.766	0.327 **	-1.51	0.347 **	0.136	0.882
Observations	1843		1843		1743		1743		1743		1743	
Pseudo R2	0.014		0.022		0.038		0.06		0.069		0.08	

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%.

Table 5 shows that the expenditure on other innovation activities in previous year and exports in previous year have a positive, significant and robust effect on the probability of obtaining public financing. On the other hand, there is a negative, significant and robust effect between specifications for firms located in the Valparaíso Region and O'Higgins Region. However, there is also a significant, robust and negative effect for small sized firms and foreign property firms.

Table 5. Results with data from the eighth innovation survey

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error
Expenditure on equipment for innovation in t -1	4.06E-08	1.1E-07	4.41E-08	1.1E-07	5.59E-08	1.1E-07	5.67E-08	1.1E-07	4.56E-08	1.1E-07	3.98E-08	1.2E-07
Expenditure on external knowledge in t -1	2.8E-06	5.3E-06	3.7E-06	5.1E-06	4E-06	5.2E-06	4.2E-06	5.3E-06	3.8E-06	5.6E-06	3.8E-06	5.6E-06
Expenditure on training for innovation in t -1	-3E-07	2.6E-06	-6E-07	2.7E-06	-9E-07	2.8E-06	-1E-06	2.9E-06	-1E-06	3E-06	-1E-06	3.6E-06
Expense on introd. of innovations to the market t -1	-2E-06	1.1E-05	-1E-06	1.2E-05	-4E-06	1.2E-05	-2E-06	1.3E-05	-2E-06	1.4E-05	-1E-06	1.3E-05
Expenditure on other innovation activities in t -1	8.9E-06	2.6E-06 **	9.6E-06	3.2E-06 **	1E-05	3.3E-06 **	1E-05	3.4E-06 **	1E-05	3.5E-06 **	9E-06	3.5E-06 *
No. of Intellectual property rights in t -1	0.0227	0.0274	0.0121	0.028	0.0146	0.0292	0.015	0.0295	0.0163	0.0304	0.0191	0.0296
Total sales in t -1			-7E-08	6.7E-08	-7E-08	6.7E-08	-8E-08	6.9E-08	-2E-07	1E-07 *	-2E-07	1E-07 *
Number of workers in t -1			-0.0004	0.00066	-0.0004	0.00067	-0.0004	0.00066	-0.0005	0.00069	-0.0009	0.00079
Exports in t -1			0.539	0.149 **	0.568	0.155 **	0.573	0.16 **	0.543	0.161 **	0.55	0.164 **
Agricultural and forestry sector					0.514	0.274	0.555	0.283 *	0.584	0.284 *	0.576	0.284 *
Fishing sector					0.182	0.352	0.226	0.365	0.288	0.367	0.287	0.367
Mining sector					.	.	.	.	.	.	.	.
Manufacturing sector					-0.0509	0.245	-0.0297	0.254	-0.0223	0.255	-0.0374	0.255
Electricity, gas and water sector					.	.	.	.	.	.	.	.
Construction sector					0.372	0.279	0.404	0.289	0.412	0.29	0.419	0.29
Commerce sector					0.219	0.269	0.227	0.279	0.256	0.279	0.244	0.279
Transport sector					0.0737	0.287	0.124	0.297	0.119	0.299	0.118	0.299
Financial Services sector					-0.282	0.455	-0.221	0.463	-0.182	0.461	-0.193	0.461
Real estate sector					0.411	0.242	0.456	0.25	0.468	0.251	0.454	0.252
Social and health services sector					-0.264	0.389	-0.247	0.392	-0.24	0.393	-0.297	0.399
Other sectors					-0.0951	0.334	-0.0716	0.34	-0.0607	0.341	-0.0712	0.342
Tarapacá Region							-0.392	0.352	-0.397	0.354	-0.384	0.356
Antofagasta Region							-0.414	0.349	-0.442	0.35	-0.433	0.352
Atacama Region							-0.477	0.384	-0.489	0.383	-0.475	0.384
Coquimbo Region							-0.253	0.332	-0.301	0.334	-0.283	0.336
Valparaíso Region							-1.16	0.413 **	-1.21	0.416 **	-1.194	0.418 **
O'Higgins Region							-1.005	0.438 *	-1.05	0.435 *	-1.03	0.436 *
Maule Region							-0.417	0.325	-0.459	0.327	-0.436	0.329
Bío Bío Region							-0.382	0.284	-0.404	0.284	-0.385	0.286
Araucania Region							-0.173	0.295	-0.197	0.295	-0.167	0.297
Los Lagos Region							-0.102	0.275	-0.157	0.276	-0.127	0.278
Aysén Region							0.476	0.341	0.443	0.341	0.468	0.344
Magallanes Region							-0.368	0.361	-0.357	0.361	-0.333	0.363
Metropolitan Region							-0.417	0.235	-0.459	0.236	-0.449	0.238
Los Rios Region							-0.207	0.339	-0.249	0.344	-0.235	0.346
Small firm									-0.344	0.129 **	-0.355	0.13 **
Private property											-1.149	0.608
Foreign Property											-1.563	0.774 *
Mixed Property											-0.742	0.756
Constant	-1.725	0.0455 **	-1.716	0.0624 **	-1.883	0.227 **	-1.543	0.309 **	-1.223	0.332 **	-0.0667	0.706
Observations	2428		2428		2406		2406		2406		2406	
Pseudo R2	0.022		0.037		0.066		0.099		0.107		0.113	

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%.

Table 6 shows that the expenditure on training for innovation and number of intellectual property rights in previous year have a positive, significant and robust effect on the probability of obtaining public financing. Moreover, there is also a significant, robust and negative effect of total sales in previous year. At sectoral level, it is observed that the manufacturing, commerce and transport sector have a negative, significant and robust effect.

Table 6. Results with data from the ninth innovation survey

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error
Expenditure on equipment for innovation in t -1	9,3E-07	6,2E-07	2,8E-06	9,4E-07 **	2,6E-06	9,6E-07 **	2,7E-06	9,7E-07 **	2,9E-06	1,1E-06 **	2,9E-06	1,1E-06 **
Expenditure on external knowledge in t -1	4,3E-05	2,6E-05	4,2E-05	2,6E-05	4,2E-05	2,7E-05	4,1E-05	2,7E-05	4,2E-05	2,7E-05	4,1E-05	2,7E-05
Expenditure on training for innovation in t -1	7E-05	1,9E-05 **	7,7E-05	2E-05	7,8E-05	2,1E-05 **	7,4E-05	2,1E-05	7,4E-05	2,1E-05	7,3E-05	2,2E-05 **
Expense on introd. of innovations to the market t -1	5E-06	1,7E-05	7,6E-06	1,8E-05	8,1E-06	1,8E-05	9,2E-06	1,8E-05	9,1E-06	1,8E-05	9,1E-06	1,8E-05
Expenditure on other innovation activities in t -1	1,6E-05	8,4E-06	1,7E-05	8,6E-06 *	1,5E-05	8,6E-06	1,4E-05	8,7E-06	1,4E-05	8,8E-06	1,4E-05	8,8E-06
No. of Intellectual property rights in t -1	0,211	0,0436 **	0,221	0,0447 **	0,221	0,0455 **	0,238	0,0495 **	0,24	0,0499 **	0,238	0,05 **
Total sales in t -1			-3E-07	1,2E-07 **	-3E-07	1,2E-07 *	-3E-07	1,2E-07 *	-3E-07	1,6E-07 *	-3E-07	1,6E-07 *
Number of workers in t -1			0,00105	0,00085	0,00084	0,00095	0,00084	0,00101	0,00082	0,00102	0,00074	0,00112
Exports in t -1			0,287	0,223	0,277	0,233	0,242	0,241	0,236	0,242	0,254	0,245
Agricultural and forestry sector					-0,131	0,225	-0,159	0,234	-0,162	0,234	-0,165	0,235
Fishing sector					,	,	,	,	,	,	,	,
Mining sector					,	,	,	,	,	,	,	,
Manufacturing sector					-0,516	0,21 *	-0,562	0,217 **	-0,572	0,218 **	-0,583	0,219 **
Electricity, gas and water sector					,	,	,	,	,	,	,	,
Construction sector					-0,6	0,327	-0,625	0,338	-0,633	0,339	-0,642	0,34
Commerce sector					-0,768	0,303 *	-0,773	0,309 *	-0,775	0,309 *	-0,785	0,309 *
Transport sector					-1,021	0,405 *	-1,05	0,412 *	-1,053	0,412 *	-1,048	0,413 *
Financial Services sector					,	,	,	,	,	,	,	,
Real estate sector					-0,321	0,2	-0,34	0,207	-0,344	0,207	-0,338	0,208
Social and health services sector					-0,477	0,323	-0,531	0,333	-0,537	0,332	-0,547	0,334
Other sectors					-0,387	0,308	-0,39	0,314	-0,397	0,314	-0,406	0,314
Tarapacá Region							3,607	191,5	3,549	166,4	3,555	164,4
Antofagasta Region							3,091	191,5	3,033	166,4	3,044	164,4
Atacama Region							,	,	,	,	,	,
Coquimbo Region							3,016	191,5	2,961	166,4	2,955	164,4
Valparaíso Region							3,457	191,5	3,401	166,4	3,406	164,4
O'Higgins Region							3,045	191,5	2,985	166,4	2,987	164,4
Maule Region							3,795	191,5	3,734	166,4	3,748	164,4
Bío Bío Region							3,303	191,5	3,239	166,4	3,242	164,4
Araucania Region							3,396	191,5	3,337	166,4	3,342	164,4
Los Lagos Region							2,947	191,5	2,886	166,4	2,89	164,4
Aysén Region							3,665	191,5	3,605	166,4	3,604	164,4
Magallanes Region							3,599	191,5	3,54	166,4	3,544	164,4
Metropolitan Region							3,436	191,5	3,378	166,4	3,384	164,4
Los Rios Region							,	,	,	,	,	,
Small firm									-0,0953	0,177	-0,0974	0,178
Private property											-0,0886	0,754
Foreign Property											,	,
Mixed Property											,	,
Constant	-2,238	0,06 **	-2,112	0,0766 **	-1,701	0,166 **	-5,092	191,5	-4,939	166,4	-4,845	164,4
Observations	3280		3280		3076		2925		2925		2862	
Pseudo R2	0,094		0,113		0,144		0,167		0,167		0,167	

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%.

To contrast the previous results, a binary choice model using pseudo-panel data is estimated. Table 7 shows that the expenditure on introduction of innovations to the market in previous year and exports in previous year have a positive, significant and robust effect on the probability of obtaining public financing. At sectoral level, it is observed that the real state sector also has a positive, significant and robust effect. However, the expenditures on introduction of innovations to the market and external knowledge in previous year have no robust effects in magnitude, sign and / or statistical significance.

Table 7. Results with pseudo-panel data from innovation surveys

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error	Coef.	St. Error
Expenditure on equipment for innovation in t -1	2,6E-07	4,7E-07	-9E-07	5E-07	-3E-07	5,5E-07	-7E-07	7,3E-07	-8E-07	7,9E-07	-4E-07	9,3E-07
Expenditure on external knowledge in t -1	-3E-07	3,8E-06	6,1E-06	4E-06	1,3E-05	4,8E-06 **	1,4E-05	6,1E-06 *	1,4E-05	6,2E-06 *	1,7E-05	7,2E-06 *
Expenditure on training for innovation in t -1	3,8E-06 **	9,8E-07	6,4E-06	1,7E-06 **	5,4E-06	1,9E-06 **	3,1E-06	2,3E-06	3,6E-06	2,7E-06	2,1E-06	2,9E-06
Expense on introd. of innovations to the market t -1	1,9E-05 **	4,2E-06	2,6E-05	4,4E-06 **	1,5E-05	4,9E-06 **	2,1E-05	7,7E-06 **	2,1E-05	7,7E-06 **	2E-05	8,1E-06 *
Expenditure on other innovation activities in t -1	5,9E-05 **	1,2E-05	-3E-05	2E-05	-5E-05	2,2E-05 *	-9E-05	3,1E-05 **	-8E-05	3,6E-05 *	-9E-05	4E-05 *
No. of Intellectual property rights in t -1	0,00201	0,0159	0,0102	0,0162	0,019	0,0204	0,0384	0,0303	0,0361	0,0309	0,036	0,0315
Total sales in t -1			-1E-07	4,1E-08 **	-1E-07	4,3E-08 **	-9E-08	5,2E-08	-1E-07	6,7E-08	-7E-08	7,3E-08
Number of workers in t -1			0,00398	0,00105 **	0,00355	0,00122 **	0,00459	0,00215 *	0,00396	0,00278	0,00324	0,00306
Exports in t -1			3,555	0,583 **	5,936	0,899 **	5,658	1,365 **	5,393	1,557 **	8,431	2,32 **
Agricultural and forestry sector					0,0424	0,137	0,37	0,242	0,404	0,26	-0,0659	0,349
Fishing sector					-0,478	0,308	-0,464	0,426	-0,467	0,423	-0,951	0,508
Mining sector					-0,827	3,342	-17,18	22,09	-15,1	22,72	-6,24	23,44
Manufacturing sector					-0,215	0,0839 *	-0,0342	0,209	-0,0426	0,209	-0,61	0,339
Electricity, gas and water sector					0,144	0,723	-0,595	0,9	-0,784	1,066	1,418	1,714
Construction sector					0,423	0,171 *	0,408	0,27	0,364	0,297	0,313	0,3
Commerce sector					0,0123	0,143	0,114	0,31	0,0901	0,314	-0,224	0,337
Transport sector					-0,25	0,165	-0,08	0,297	-0,105	0,303	-0,19	0,33
Financial Services sector					-0,201	0,369	-0,133	0,54	-0,158	0,559	0,116	0,625
Real estate sector					0,472	0,0874 **	0,544	0,187 **	0,517	0,201 *	0,619	0,215 **
Social and health services sector					0,148	0,223	0,544	0,364	0,523	0,366	0,915	0,555
Other sectors					0,174	0,305	0,554	0,43	0,558	0,429	0,472	0,453
Tarapacá Region							1,204	3,158	0,446	3,829	0,848	4,033
Antofagasta Region							-4,191	3,256	-3,566	3,705	-0,811	4,088
Atacama Region							3,688	2,94	3,269	3,162	-1,698	5,426
Coquimbo Region							6,787	4,878	7,976	5,942	-0,5	7,962
Valparaíso Region							-3,453	1,929	-3,833	2,222	-2,453	2,645
O'Higgins Region							-0,533	2,792	-0,831	2,907	-1,97	3,59
Maule Region							-2,642	2,802	-2,4	2,878	-2,343	3,285
Bío Bío Region							-0,404	1,514	-0,479	1,523	1,509	1,85
Araucania Region							2,609	1,86	2,869	2,006	6,002	2,64 *
Los Lagos Region							-0,714	1,585	-0,758	1,577	-1,907	1,788
Aysén Region							1,738	3,766	1,736	3,749	4,415	4,134
Magallanes Region							-5,771	3,175	-6,092	3,29	-5,645	4,07
Metropolitan Region							0,0519	0,36	0,0444	0,36	0,0646	0,379
Los Rios Region							1,7	3,416	1,654	3,394	2,75	3,893
Small firm									-0,341	0,981	-0,16	1,155
Private property											11,45	8,634
Foreign Property											-1,775	10,34
Mixed Property											15,51	10,56
Constant	-1,978	0,0317 **	-2,224	0,072 **	-2,392	0,0978 **	-2,319	0,25 **	-2,049	0,813 *	-13,56	8,524
Observations	12039		12039		12039		12039		12039		12039	
Pseudo R2	0,016		0,029		0,044		0,053		0,053		0,055	

Source: Own elaboration. Note: (*) significant at 5% and (**) significant at 1%

4. Conclusions

It is possible to conclude, using pseudo-panels and cross-sectional data, that policymakers and members of evaluating committees follow a strategy of "picking the winner" because small and medium sized firms that have some type of expenditures on innovation activities in previous year are more likely to obtain public support for innovation.

By using pseudo-panels, it is observed that firms with expenditure on introduction of innovations to the market in previous year and exports in previous year have more probability to obtain public support for innovation. On the other hand, with cross-sectional data, there are different expenditures on innovation activities in previous year that affect the probability of obtaining public support, depending of the version of Innovation Survey.

When comparing the above results with the international literature, it is observed that the factors that explain the allocation of public funds for innovation in other countries are more diverse than those observed in the case of Chile, which leads to the conclusion that perhaps the award criteria of these funds should be changed to guide the earlier innovative actions of the applicant firms.

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