Technical innovation in regions of Chile: similarities and differences

Francisco Eduardo Gatica Neira[a]

[a] University of Bío-Bío, Chile. Email: fgatica@ubiobio.cl

The author would like to thank the indispensable commentaries from the journal's anonymous reviewers.
The opinions expressed in this paper are exclusively those of the author.

Date received: November 27, 2018. Date accepted: April 8, 2019.

Abstract

This paper seeks to determine the factors which explain differing levels of innovation in Chile at the regional level. Data used in the study was obtained from the Tenth Inquiry into Innovation in Businesses 2016, published in 2018 by the National Institute of Statistics (INE). Binary logistic regressions (Logit) were developed for each region, identifying the specific explanatory factors which determine the greatest likelihood of innovation among local businesses. The study concludes that the heterogeneities detected call for an adjustment in public policies in accordance with regional dynamics, which should be understood as subnational spaces.

Keywords: innovation management; innovative businesses; regional systems; I & D; public policies; discrete regression model.

INTRODUCTION

This article seeks to identify heterogeneities among the different Chilean regions, using as a foundation the innovation rates in each and the factors that explain these rates in each case. These differences oblige Chile to have specific public policies focused on stimulating regional competitiveness in the setting created by the new Ministry of Science, Technology, Knowledge, and Innovation.

To begin with, this work carries out a bibliographical review regarding the regional innovation systems and the productive clusters. It seeks to develop a variety of analytical elements which will allow the generation of a taxonomy for classifying the country's different regions. Second, a methodology which delves into calculating the regional innovation rates and the reach of binary logistic regression models (Logit) is presented.

The field study entailed the analysis of different regional innovation rates with results from the regional models presented for each explicative variable proposed. Furthermore, each region is spatially identified in the quadrants derived from the innovation rate's explicative factors and taxonomy. Finally, based on the results obtained, different public policy initiatives are proposed in the conclusions for each of the classifications.

2. REGIONAL CLASSIFICATIONS

The Chilean economy is lagging behind when it comes to R&D and the development of human resources, thereby limiting its growth model. Calderón and Castells (2016) venture that in the case of Chile, there is a "neoliberal mentality" which still pervades the Ministry of Economy (MINECON). The result of this is that technological modernization has been left up to the market's forces and, as such, has ended up being inefficient depending on the sector, in addition to resulting in social disparity from a territorial point of view.

The current social and economic heterogeneity in Chile calls for the further empowerment of regional innovation systems, thanks mostly due to the R&D talent concentrated in the national capital. In that regard, according to the 7th National Survey of Personnel and Expenses in R&D (MINECON, 2018), in 2016, 70% of R&D spending happened in the capital, Santiago. This datum reveals the high level of centralization of private and public investments in factors facilitating innovation. As such it appears that the spatial inequity constitutes a factor in dire need of correcting so that a long-term sustainable growth model may be reached.

Facing this, it is important to have specific regional policies within the context of the recently enacted law 21.105, which for the first time, creates the Ministry of Science, Technology, Knowledge and Innovation, so that based on the acknowledgement of the different variables which explain innovation in businesses located in the region, a set of specific initiatives which favor the harmonious development of Chile can be generated.

This work outlines a study of the efficiency of regional innovation systems, generating a taxonomy based on the intensity of innovation in the regions. The traditional classifications are constructed based on different variables grouped into three categories: 1) the facilitating variables identifying human resources, financing, and support, 2) the company's own variables, which cover private investments, connections, and entrepreneurship, and 3) the parameters which reflect the results of innovative results and products and their economic effects (Molero, 2012).

In this context, it is the Regional Innovation Scoreboard (European Commission, 2017), where there is an annual comparative evaluation on the subject of research and performance in innovation for the member states of the union European Union, which is a great resource for targeting the different efforts. In this systematic comparative exercise, four large groups are identified according to their innovative performance: 1) regions leading in innovation (53), 2) strong innovators (60), 3) the moderately innovative (85), and 4) those classified as modestly innovative (22). This analysis allows us to identify the "pockets of excellence" inside every country.

Along the same lines, in the case of Spain there is the analysis of Buesa *et al.* (2015) which analyzes the efficiency of the Regional Innovation System with a Data Envelopment Analysis (DEA) combined with the factor analysis. Four factors are identified as configuring the innovation rate of systems: 1) the quantity of innovative businesses, 2)

public administrations, 3) universities, and 4) the presence of scientific and technological policies incorporated in a "National R&D+i Plan." As such, the variables of the results are: the number of patents, the number of utility models, and the quantity of scientific publications per region. The conclusion of the work is that in spite of strong differences between regions, in dynamic terms, there is greater convergence: the lagging regions display a relative improvement and the "border performance" shows stagnation stemming from the impact generated by the Spanish crisis.

This analysis' hypothesis is that the regions in Chile present different conditions or factors which stimulate innovation in businesses. As such, there is a need for specific public policies with a framework for regional incentives in order to reach a harmonious development in the country.

Next, I will develop the concept of resources, regional innovation systems and productive clusters in order to understand the behavior of business innovation in a specific territory.

Territorial Dimension of Innovation

Lundvall (1999) presents four forms of learning: 1) during production, 2) during use, 3) via interaction, 4) via R&D. This learning is most intense when there is geographical proximity (Dallasega *et al*., 2018). Present in each region are different degrees of clusterization of the innovative activities in the area due to the fact that businesses with greater technological content are found in those zones where there is greater stock of technological knowledge.

In this context are two theoretical models to explain the distribution of innovation in the area:

1) Territorial Innovation Systems

A group of actors which are interconnected and which carry out the activities of creation and distribution of new knowledge within a specific institutional and geographical framework in order to give way to innovations, primarily technological, upon which economic development rests (Buesa *et al.*, 2015).

In this regard, three factors are identified in the system which can influence the direction and vigor of the innovative activities in the region (Tidd *et al.*,1999; Cimolli, 2000). These are: 1) the institutions given that their level of interconnectedness is important; the strategic mandates regarding research and development; the protection systems which ensure the appropriability of the benefits and policies geared towards qualifying the workforce, 2) the competencies learned and accrued over time, and 3) the incentives and pressures from the local market.

The possibility of producing and accumulating technological knowledge at the level of local businesses will depend upon the existence of an efficient regional innovation system. The case which has most inspired public policies in Latin America is that of Silicon Valley (Castells and Hall, 1994; Saxenian 2016), where it has been proven the importance of counting on an innovative medium with risk capital, a highly qualified workforce, emerging technologies, different local leaderships, and the presence of local networks which stimulate innovation

2) Productive Clusters

The concept was developed by Porter (1991 and 2009), inspired by the model of Italian Industrial Districts. A cluster is a group of businesses which are interconnected and find themselves densely localized in a set territory. Within this grouping of businesses arise processes of innovation and distribution which make participation in the cluster an attractive prospect.

A work which analyzes the clusters in creative industries is that of Gong and Hassink (2017). It determines three processes which reinforce the development of these clusters: 1) the economies of agglomeration, where we can essentially find in effect centripetal forces, the draw felt by businesses, the development in large metropolises, and access to specialized suppliers, 2) the development of spinoffs where parent companies play a key role, the proximity of universities, and the presence of leaders willing to take action, and 3) an institutional setting, where importance is given to protection mechanisms, normative frameworks for distribution, and public development agencies, the support provided by universities, incubators, qualified human capital, and institutional articulation at different levels.

Boix *et al*. (2015), Villareal and Flores (2015), and Seongsoo *et al.* (2017) open up the possibility of starting a subcluster in specific locations in regions and even in cities, as it is important to identify to what degree the business found in the subcluster accesses the various other subgroups, thereby increasing its innovative capabilities.

Both theoretical approaches, regional innovation systems and productive clusters, complement each other, thereby explaining the rate of innovation in the region. From these approaches arise five groups of parameters which explain the probability of innovation in regional businesses. These groups of variables, which are used in this study, are: 1) The accumulation of abilities or skills, 2) interactive learning, 3) human resources, 4) public policies, and 5) the path dependencies, which we will look at later on.

Need for a Regional Taxonomy

In order to identify a territorial heterogeneity with regards to innovation, from the meeting of two axes, a classification is proposed for the regions (which one should understand to mean as subnational spaces):

- *Innovation rate*: seeks to identify the regions which have, in relative terms, a greater number of businesses which are innovating in the territory
- *Number of variables which influence innovation*: indicator of the regional complexity and variety at the moment of determining innovation in regional businesses

From the crossing of these axes arises a taxonomy for patterns of regional innovation in order to identify heterogeneity in subnational spaces at the moment of innovation. This turns out to be an important vector within the context of the new Ministry of Science, Technology, Knowledge and Innovation (Law 21.105, published Aug. 13 th, 2018).

From the aforementioned combinations one can identify the following four groups (see Chart 1):

Chart 1. Taxonomy of regional innovation patterns

Definitions		*Rate of Innovation = (Number of innovative businesses/ Total number of businesses)*	
	Typology	*Low rate of innovation (less than average)*	*High rate of innovation (above average)*
Number of expected variables for innovation in the businesses.	Regions with many variables which influence the probability of innovation (above the average).	Type C: Territory with low efficiency. We have a regional system with variables for stimulating business innovation but which fail to create the required synergy.	Type A: A regional system which is more organized, with efficient results in business innovation. Dynamic sectors found in a complex environment.
	Regions with few variables capable of influencing innovation (below the average).	Type D: Lagging territory. There is a low rate of innovative businesses and a regional system with low in variety and synergy.	Type B: Territory with innovation poles. Can have a high rate of regional innovation which is not explained by local synergies.

Source: created by the author.

i. Competitive Territory (Type A). Where the region presents a high rate of innovation and in a parallel fashion a high variety of factors which explain a competitive business. In this case one can expect the presence of a more developed innovation system and the presence of microclusters.
ii. Territories with innovation poles (Type B). The region has a high rate of innovation, but a low quantity of factors to explain it. This can evince the presence of innovative companies isolated from their surroundings.
iii. Territory with low efficiency (Type C). In this case one can find a variety of factors which can explain innovation, yet the regional system lacks the synergy required to reach a greater level of efficiency.
iv. Lagging territory (Type D). The region presents a low rate of innovation in addition to having few factors with which to stimulate technological change. Here we have a vicious cycle: an environment lacking in complexity>a gathering of businesses lacking in complexity>a low rate of innovation>the impoverishment of the environment brought about by a drain of qualified human capital>bringing us back to an environment lacking in complexity.

Regarding Explicative Variables

This analysis works with five groupings of variables in order to explain the probability of innovation in regional businesses. In spite of the analysis model (Logit) appearing extensively throughout the methodology, and taking into consideration that the focus is the comparison between regions in order to identify heterogeneities, we will now look at some theoretical dimensions, which have been sorted by a grouping of skills, interactive learning, human resources, public policies, and path dependencies. This grouping of parameters based on the available data, was worked over at the moment of analyzing the Innovation Survey in a group of ICT companies (Gatica, 2018).

- *Grouping of skills*. In this group, we have three variables: 1) age of the company (years), 2) the presence of foreign capital, and 3) belonging to a business group. These parameters are associated with a Deep Innovation Model (Breschi and Malerba, 1997) where what matters are the specialized context frameworks and the accumulated knowledge as a result of the business's history. The presence of foreign capital and belonging to business groups also allows access to knowledge and innovations generated in other businesses in the same group.
- *Interactive learning*. In this group, we have sales and exports. Both parameters presuppose positive relationships, stemming from the idea of customer-supplier learning, developed by Lundvall (1999). Along these lines lies the possibility of selling to foreign clients which would be a stimulus for innovation via access to a greater variety of technological and economic realities.
- *Human resources*. In this category, we find the total workforce; professional and technical, with post-graduate studies, subcontracted and total. To begin with, the total size of the workforce would be indicative of the scale of production. The greater the volume of production, the more probable it is to detect a deep innovation model (Breschi and Malerba, 1997). It is worth mentioning that the innovation

produced in large businesses, with specialized structures which reach high economies of scale. The importance of a workforce with postgraduate studies is explained by how fundamental qualified human capital ends up being in innovation processes. Finally, the processes of subcontracting allow businesses to focus on activities which generate value by externalizing that which is routine.

- *Public policies*. There are three parameters in this group: 1) the presence of R&D in regions other than the national capital, 2) the presence of R&D in the national capital, and 3) supporting public policies (0/1). The separation of R&D expenses carried out in the national capital from that carried out in other regions is associated with innovation systems (Tidd *et al*., 1999; Cimolli, 2000), where a positive and significant relationship between R&D in the regions, at the moment of explaining innovation in local businesses, justifies the importance of decentralizing said investment. This way the support of the public policies should have a positive impact on the company which is innovating and constitutes a key tool in the regional innovation system.
- *Path Dependencies*. Two variables correspond to this category: 1) diversity of innovative sources and 2) expectations of innovation in the following year. These variables are supported in the so-called evolutionary approach (Dosi, 1982 and 1998; Metcalfe, 1994) where the possibility of innovating in the future is associated with a past history of innovation. On the other hand, diversity of sources is associated with the possibility that the company could access a greater variety, thereby increasing its possibilities of innovating (Dallasega *et al.*, 2018).

A more schematic development of each explicative variable is presented in Chart 2 of this work.

Chart 2. Summary of dependent variables in Logit model
Dependent variable: Innovative business (1/0)

Dependent Variable	*Explanation*	*Type of relationship expected*
Antigüedad [a]	Age of the business (years)	Positive relationship (+). As companies advance through time, they accumulate technological skills which facilitate innovation.
Propieextranj	Presence of foreign capital (0/1)	Positive relationship (+). This explains that when there is foreign capital at play, it increases the probability of foreign technological transfers.
Pertegrupoempresa	Belonging to a business group (0/1)	Positive relationship (+). Belonging to a group increases the innovative stimuli, thanks to access to economies of scale.
Ventas2016M	Sales in millions of pesos in 2016	Positive relationship (+). The ability to take on the costs of innovation and, in particular, the costs of R&D.
Exportaciones2016M	Value of exports in millions of pesos for 2016.	Possible relationship (+). Greater exports increase the probability of innovation as a result of the stimulus provided by the need to meet the demands of international markets.
MOProfytecn	Total workforce, both professional and technical.	Positive relationship (+). The presence of qualified human capital facilitates innovation.
MOconpostgrado	Total workforce with postgraduate studies.	Positive relationship (+). The presence of qualified human capital facilitates innovation.
TotalMO	Total workforce	Positive relationship (+). Economies of scale allows one to take on greater costs for innovation.
MOsubcontratados	Total workforce which has been subcontracted.	Positive relationship (+). The externalization or outsourcing of routine tasks frees up qualified human capital for tasks which have greater strategic value.
Idregiones	Presence of R&D in regions other than the national capital.	Positive relationship (+). R&D in regions which are not the capital of the country, allows an increase in the probability that the company will be innovative.
IdRM	Presence of R&D in the national capital.	Positive relationship (+). The companies which have R&D in the metropolitan region have a greater probability of innovation.
Tuvoapoyodepolit	Benefitted from the support of public policies (0/1).	Positive relationship (+). The hypothesis proposes a direct relationship between the presence of public resources and innovation.
Diversidaddfuent	Diverse innovative sources.	Positive relationship (+). It is expected that the probability to innovate will be greater as the sources of innovation available increases (evolutionary approach).
Ambitosinnvocenf	There are expectations of innovation in the following year.	Positive relationship (+). The probability of innovating in one in one year zero is in direct positive relationship with the expectation of innovation in one year (future).

Note: [a] Variables in graphics/equations have been kept in the original Spanish, however these correspond to "Age; Foreign holdings; Belonging to a business group; Sales2016, Millions; Exports2016, Millions; Technically proficient workforce; Workforce with postgraduate studies; Total Workforce; Subcontracted workforce; R&D Regions; R&D in MR; W/Support from public policies; Diverse innovative sources; Focus on innovative setting" respectively.

Source: Created by the author.

3. METHODOLOGY

The 10 th Survey of Innovation in Businesses, 2016, from the National Statistics Institute (INE), published in 2017 was used in the study. This survey has national coverage and generated information by region.

In order to estimate the sample size, the INE considered two elements: random inclusion and forced inclusion, the latter being that which was applied when a selection had few units for sampling. In this context: sampled structure = 178,123 businesses; sample total = 5,500 businesses; forced inclusion = 1,858; random inclusion = 3,642 with a coefficient variation of 5.28%.

Based on the survey two supplementary analyses were created:

i. a rate of innovation is determined for each region. For each business, I determine whether there is any of the 13 types of innovation proposed by the Innovation Survey. In order to be considered innovative it is enough for a company surveyed to present at least one type of innovation. The types of innovation managed by the INE are: *1)* new goods, *2)* new services, *3)* new production methods, *4)* new logistics methods, *5)* new support, *6)* new organizational practices, *7)* new organizational methods for responsibilities, *8)* new organizational methods for external affairs, *9)* changes in design, *10)* new promoting methods, *11)* new methods for distribution channels, *12)* new pricing methods, and *13)* social innovation.

With this definition, the innovation rate was constructed for each region where:

$$Regional\ innovarion\ rate\ j = ((\sum \frac{innovative\ bussinesses\ in\ region\ j}{businesses\ surveyed\ in\ the\ region\ j}) * 100)$$

Where *j* = specific region

ii. the second axis of analysis is the identification of different explicative variables for the probability of innovation in each business. For this purpose, different binary logistic regression models were generated (Logit) for each region (Hair *et al*., 1999), where the dependent variable is the presence of innovation (0/1) and the independent variables considered (12), proposed previously are those available in the survey and which allow better identification of the explicative variables for innovative probabilities in the 5,857 businesses.

15 Logit models were generated (one for each region of the country) which repeat the following structure:

Probability of being an innovative business in the region j (1/0) = *F (age (i), presence of foreign capital (i), belonging to a business group (i), sales (i), exports (i), technical and professional workforce (i), workforce with postgraduate studies (i), total workforce (i) subcontracted workforce (i), presence of R&D in regions other than the national capital (i) presence of R&D in the national capital (i) variety of innovative sources (i) and the presence of support from public policies* (0/1)).

Where the business is (*i*) in region (*J*)

For the binary logistic regressions (logit), the open source software for econometrics theory known as GRETL (see http://gretl.sourceforge.net/) was used. All the Logit models presented a rate of "predicted cases" above 92%. Furthermore, multicollinearity presenting a variance inflation factor (VIF) under 10 was written off. Finally, the McFadden R-Squared was above 0.52 for all the models.

4. RESULTS FROM FIELD STUDY

The results of the interregional distribution of innovative businesses will now be presented. In the following section the factors which explain business innovation from an interregional point of view will be analyzed. Finally, the interregional similarities or differences based on the rate of innovation and explicative factors will be developed. For the analysis of the similarities an initial identification of the territories using all the regions of the country will first be considered and from the results a second analysis will be generated, excluding the national capital (Metropolitan region, Santiago de Chile).

Interregional distribution of innovative businesses

Upon analyzing the relationship between regional innovation rates and the distribution of businesses surveyed, it was proven that:

- Among the regions with the highest innovation rates (see Table 1, column D) are those with conurbations: Metropolitan (39% of innovative businesses), Valparaiso (8.6%), and Biobio (7.5%). These territories have denser productive makeups, with a greater quantity of universities, the presence of qualified human capital which has reached critical mass, and a major R&D investment, that is to say: 70, 10.2, and 4.9%, respectively (MINECON, 2018).
- On the other hand, there are six territories whose share of innovative businesses varies between 1% to 3%.

- There are 11 regions whose share of the total innovative businesses (see Table 1, column D), is below their share in the national business park surveyed (see Table 1. Column B), which constitutes a situation of "hypothetical loss".
- On average 23.6% of Chilean businesses present some type of innovation. It is interesting as a comparison that 23.4% of Spanish industrial businesses are classified as innovative (Morales *et al*., 2018). This similarity of regional rates shows a consistency in methodology at the moment of constructing the data.

Table 1. Distribution of businesses surveyed versus innovative businesses.

Regions	*A) Total businesses surveyed*	*B) Distribution of businesses surveyed %*	*C) Number of innovative businesses*	*D) Distribution of innovative businesses %*	*Differential rate of innovation minus businesses surveyed (D-B)*	*Rates of innovation %*
R1 Tarapacá	202	3.4	35	2.5	-0.9	17.3
R2 Antofagasta	244	4.2	63	4.6	0.4	25.8
R3 Atacama	176	3.0	37	2.7	-0.3	21.0
R4 Coquimbo	273	4.6	62	4.5	-0.2	22.7
R5 Valparaíso	488	8.3	119	8.6	0.3	24.4
R6 O'Higgins	284	4.8	56	4.0	-0.8	19.7
R7 Maule	325	5.5	71	5.1	-0.4	21.8
R8 Biobío	467	7.9	104	7.5	-0.4	22.3
R9 Araucanía	315	5.4	67	4.8	-0.5	21.3
R10 Los Lagos	436	7.4	99	7.2	-0.3	22.7
R11 Aysén	123	2.1	35	2.5	0.4	28.5
R12 Magallanes	207	3.5	34	2.5	-1.1	16.4
R13 Metropolitana	2 012	34.2	540	39.0	4.8	26.8
R14 Los Ríos	190	3.2	38	2.7	-0.5	20.0
R15 Arica y Parinacota	133	2.3	24	1.7	-0.5	18.0
Country total	5 875	100.0	1 384	100.0		23.6

Source: created by the author based on the results from the National Innovation Survey.

Explicative factors for the probability of innovation in businesses

Table 2 summarizes the frequency of occurrence for significant parameters at the moment of explaining innovation in regional businesses and which is a product of the Logit models in different regions (15).

Table 2. Distribution of explicative variables at the level of the 15 regions

Variable	*Explanation*	*Regions with significant parameters*	*Significant and (+) relationship*	*% of occurrences with a significant and (+) relationship*	*Significant and (–) relationship*
Antiguedad	Age of the business (years)	1	1	7	0
propieextranj	Presence of foreign capital (0/1)	1	0	0	1
Pertegrupoempresa	Belonging to a business group (0/1)	3	3	20	0
Ventas2016M	Sales in millions of pesos in 2016	1	0	0	1
Exportaciones2016M	Value of exports in millions of pesos for 2016.	0	0	0	0
MOProfytecn	Total workforce, both professional and technical.	4	4	27	0
MOconposgrado	Total workforce with postgraduate studies.	2	0	0	2
TotalMO	Total workforce	1	1	7	0
MOsubcontratados	Total workforce which has been subcontracted.	0	0	0	0
Idregiones	Presence of R&D in regions other than the national capital.	13	13	87	0
IdRM	Presence of R&D in the national capital.	4	4	27	0
Diversidaddfuent	Diverse innovative sources.	7	7	47	0
Tuvoapoyodepolit	Benefitted from the support of public policies (0/1)	3	0	0	3
Ambitosinnvocenf	There are expectations of innovation in the following year.	12	12	80	0
Average		4	3	21	1

Source: created by the author based on Logit models.

Table 3. Explicative coefficients for innovation at a regional level

Coefficients	*R1 Tarapacá*	*R2 Antofagasta*	*R3 Atacama*	*R4 Coquimbo*	*R5 Valparaíso*	*R6 O'Higgins*	*R7 Maule*	*R8 Biobío*
constant	–3,720***	–3,330***	–3,660***	–3,340***	–3,154***	–3,838***	–3,335***	–4,541***
AntigAedad	0.007	–0,0179765	–0,000529234	–0,000785589	–0,0498417	0.008	–0,0179765	0.022
propieextranj	–0,204045	0.00525205	–0,0138574	–3,71486	0.00502751	0.0125506	0.00525205	–0,00661974
Pertegrupoempresa	–1,01210	–1,10611	0.10361	0.633427	1.15746	0.545764	–1,10611	–0,238873
Ventas2016M	–2,68583e-08	6.00969E-09	7.88E-09	–7,92710e-010	8.96E-08	1.69E-08	6.01E-09	9.37E-10
Exportaciones201~	–7,36541e-07	–2,72113e-07	–1,10500e-08	–2,29677e-06	–4,21014e-08	–2,99126e-08	–2,72113e-07	–1,57753e-09
MOProfytecn	0,01405*	0.00471933	0.00600345	0.000696809	–0,0275056	0.000642918	0,0047*	–0,00444651
MOconpostgrado	–0,217***	–0,0127723	–0,00470369	–0,0510696	–0,231031	–0,00304805	–0,0127**	–0,00472180
TotalMO	0.00323509	0.000324679	–0,00241069	0.00180765	–0,00791057	4.20E-05	0.000324679	0,0021***
MOsubcontratados	0.0086341	–0,00374134	0.00398764	–0,00560398	–0,00696913	–0,00356621	–0,00374134	0.00137758
Idregiones	0,0292**	0,0453***	0,037***	0,020**	0,056***	0,04830***	0,0453***	0,0431***
IdRM	0.0660523	0,033***	1.6269	1.83616	0.487717	0,0425***	0,0339**	1.6891
Diversidaddfuent~	13,581**	3.67556	10,70**	12,74***	11.9379	–1,55013	3.67556	8,475***
Tuvoapoyodepolit~		–0,0737360	–3,713**	0.540539	–0,666087	–0,663596	–0,0737360	–1,66703
Ambitosinnvocenf~	0.302854	0.384981	0,460***	0,424**	0,736***	0,4291***	0,384**	0,436***
McFadden R-Squared	0.645239	0.667016	0.529516	0.738794	0.549101	0.621167	0.555549	0.7096
Number of cases correctly predicted	95.00%	93.90%	92.00%	96.00%	92.00%	95.10%	94.80%	95.10%
Likelihood ratio test Chi-Squared	120,18 (0,000)	185,915 (0,000)	95,8523 (0,000)	216,114 (0,000)	297,694 (0,000)	175,167 (0,000)	219,565 (0,000)	351,466 (0,000)

Coeficientes	*R9 Araucanía*	*R10 Los Lagos*	*R11 Aysén*	*R12 Magallanes*	*R13 Metropolitana*	*R14 Los Ríos*	*R15 Arica y Parinacota*
constant	–5,011***	–3,385***	–4,320***	–5,069***	–3,794***	–5,517***	–4,281***
AntigAedad	0,0444**	0.00928241	0.0441944	0.0138032	0.00114183	0.00619299	0.052316
propieextranj	–0,371285	0.0105905	–25,7872	–0,581765	–0,00556596	0.00286183	–0,0146627
Pertegrupoempresa	0.42921	0.601417	5,34684*	1,60*	0,666***	1.66368	1.9633
Ventas2016M	2.28E-08	1.21E-08	–6,72622e-07	6.18E-09	–2,77949e-010**	8.41E-09	–4,28799e-07
Exportaciones201~	–4,08852e-07	–2,56994e-08	–0,00139917	–6,06014e-08	5.26E-10	–5,40633e-09	6.95E-08
MOProfytecn	–0,00388244	–0,00324626	0,2946**	0.0344232	0.000462813	0,0248**	–0,0107481
MOconposgrado	0.0672223	0.014139	0.327513	–1,59999	0.000546874	0.150296	0.0326429
TotalMO	0.00136701	–0,000383344	–0,153018	–0,0138713	1.43E-05	–0,000770719	0.00913379
MOsubcontratados	0.000727485	–0,000681703	–0,00407173	–0,207958	–0,000201731	–0,00278510	0.0265177
Idregiones	0,0229**	0,033***	487.406	–0,183884	0,03490***	0,0604***	0,05585***
IdRM	0.427312	3.26284	528.037	–0,973096	0,04384***		14.7039
Diversidaddfuent~	23,24***	3,671**	516.65	277.194	2,248***	0.91254	13.4584
Tuvoapoyodepolit~	–4,083**	–2,186**	–27,8669	–24,3898	–0,582688		0.0257257
Ambitosinnvocenf~	0,6324***	0,314***	0,558*	0,7583***	0,4774***	0,5715**	–0,491357
McFadden R-Squared	0.719416	0.546534	0.813185	0.762773	0.625968	0.734649	0.715075
Number of cases correctly predicted	95.60%	92.90%	98.40%	96.60%	93.40%	95.80%	96.20%
Likelihood ratio test Chi-Squared	234,552 (0,000)	255,305 (0,000)	119,466 (0,000)	141,047 (0,000)	1465,12 (0,000)	139,696 (0,000)	89,7937 (0,000)

Notes: * p value < 0,1 ; **p value < 0,05 ; ***p value < 0,01.
Source: Created by the author based on Logit models.

From the analysis, the following was concluded:

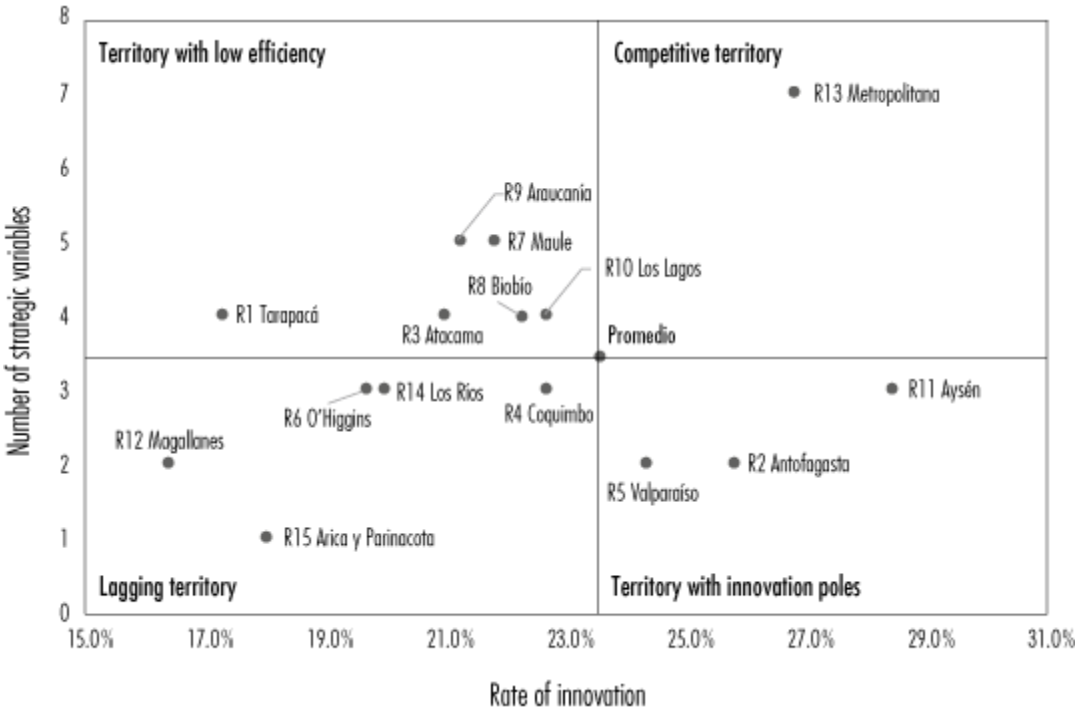
i. Variable R&D expenses in regions (Idregions) significantly explains the probability of having local innovative businesses, with said variable being a powerful force for competitiveness. This variable appears to be relevant in 87% of the regions.
ii. The expectations for innovation in the following year (t+1) ("Ambitosinnvocenf") conditions in a significant manner business innovation for this year (t). In 80% of the regions, this variable has a significant and positive impact. Presenting a path dependency where a company which aspires to innovate in the future, finds itself innovating in the present. This shows how pertinent it is to utilize the evolutionary approach at the moment of explaining innovation (Dosi, 1998). In the majority of regions, it shows itself to be relevant at the moment of determining innovative behavior, as a good predictor of business innovation in a temporal sense.
iii. Diversity in innovative sources ("Diversidadfuent") presents a significant and positive relationship. This variable is important in 47% of the territories. Theoretically, a greater variety of sources should translate into greater learning and innovation. Nevertheless, only in half of the regions is this relationship observed. This result should be interpreted as a line of study for the nascent Ministry of Science and Technology, Knowledge and Innovation, placing emphasis on the development of mezzoeconomic networks (universities, business, state, and regional general partnerships) in order to achieve greater efficiencies in innovation systems.
iv. Only in 27% of the regions does the realization of R&D in the national capital ("IDRM") appear as a significant parameter. As such, innovative businesses need not access R&D in Santiago (national capital). This reinforces the strategic impact of stimulating the decentralization of R&D spending. This is an idea which presents itself as an urgent task for the new ministry.
v. The number of technicians and professionals ("MOProfytec") is explicative of the innovation in regional businesses in 27% of cases.
vi. Belonging to a business group ("Pertegrupoem") is relevant in three regions. In 20% of the territories, belonging to a business group allows stimulus for innovation.
vii. Having a workforce with postgraduate studies, Masters and Doctorates ("MOconposgrado"), turns out to do little to explain business innovation. Only in two regions does it appear to be relevant. But contrary to expectations, the relationship was negative. From this we can deduce that the workforce with postgraduate studies has not reached critical mass in businesses or that the gap between the organization's needs and the skills had by the more advanced human capital.
viii. There are factors which do not have great importance in the interregional distribution. Here it is important to point out that the age of the business is important in only 7% of the regions. The size of the workforce ("TotalMO") only appears in one region as a significant variable. As such, the presence of foreign capital ("Propieextranj") does not explain greater innovation in businesses located in the regions. The size of the subcontracted workforce ("MOsubcontratados") does not appear to be significant in any region in the country. The volume of sales and exports does not present a significant relationship at the moment of explaining innovation in local businesses.

To be sure, the expected parameters with greater importance are related to the size of R&D policies, and in particular when they are decentralized from the path dependencies and the variety of research sources. As such, the reader will be able to see that more traditional variables (sales, total workforce, exports, among others) do not have a great explicative potential.

Global interregional similarities

For the purpose of identifying similarities and distances between regions, a visual representation of where the two axes cross was generated: on the one hand, we have the innovation rate and, on the other, the quantity of variables which are significant at the moment of explaining the probability of innovation. Four regional innovation patterns were identified (see Figure 1):

Figure 1. Rate of innovation and significant variables



Source: created by the author based on the results from the Logit models.

1) Competitive territory

Where there is a confirmed greater rate of innovation and a greater number of significant variables. In this group, the metropolitan region (Santiago) can be found exclusively. No more regions were identified within this quadrant, which proves a great disparity with the rest of subnational units. It is a territory which presents greater efficiency in its innovation system and good locational advantages for businesses with greater complexity. It is interesting that in Santiago (the national capital) local businesses show a greater probability to innovate when their R&D expenses are actually in other regions of the country.

2) Territories with innovation poles

In this case we have the region of Antofagasta with only two significant variables (R&D in regions and R&D in the metropolitan region). It is a mining territory which is strong in investment at a national level and which presents a "pole" style development in its environment. In this group, one can find the Valparaiso region which only has two significant parameters: R&D in regions and the possibility for future innovation. Finally, the region of Aysén, which presents a high percentage of innovative businesses with a low quantity of significant parameters. These territories present a greater rate of innovation which is not necessarily explained by local synergies.

3) Territory with a low efficiency

The region has parameters which could be significant at the moment of innovation but the efficiency rate of these efforts is relatively low. In this case the Tarapacá region stands out due to the diversity of innovative sources and R&D in regions. It is interesting that the presence of a workforce with postgraduate studies presents a negative relationship, which could be explained by a low critical mass or by a skills gap between the supply and demand for qualified workforce.

In this classification, one can also find the regions of Atacama and Maule, in spite of having as significant variables R&D in regions and the possibility of future innovation. In the case of Atacama, the support from public mechanisms appears as a negative and as positive the diversity of innovative sources. In the case of Maule there appears to be a negative relationship between the rate of a workforce with postgraduate studies. Also in this category, we can find the regions of Biobio with the second most important conurbation in the country, and that of Los Lagos. Finally, there is Araucanía where age as an explicative element for the probability for innovation stands out.

4) Lagging territories

Here we can find the regions of Arica and Magallanes, found at opposite ends of Chile. The prior only has one significant variable which is regional R&D. In the latter, the only variable is possible future innovation. In this category we also find the region of O'Higgins which, in spite of presenting significant variables such as regional R&D and R&D carried out at the national capital, has a low rate of innovation. A similar situation is present in Coquimbo, where we have as significant variables R&D in the region, diverse sources for innovation and the possibility for future innovation. Lastly, we have the region of Los Rios, which has as a significant factor the presence of a professional workforce, the realization of R&D and the possibility of future innovation. In these territories. We find a low rate of innovative businesses and a low regional capacity for generating synergies which could improve the efficiency of the local innovation system.

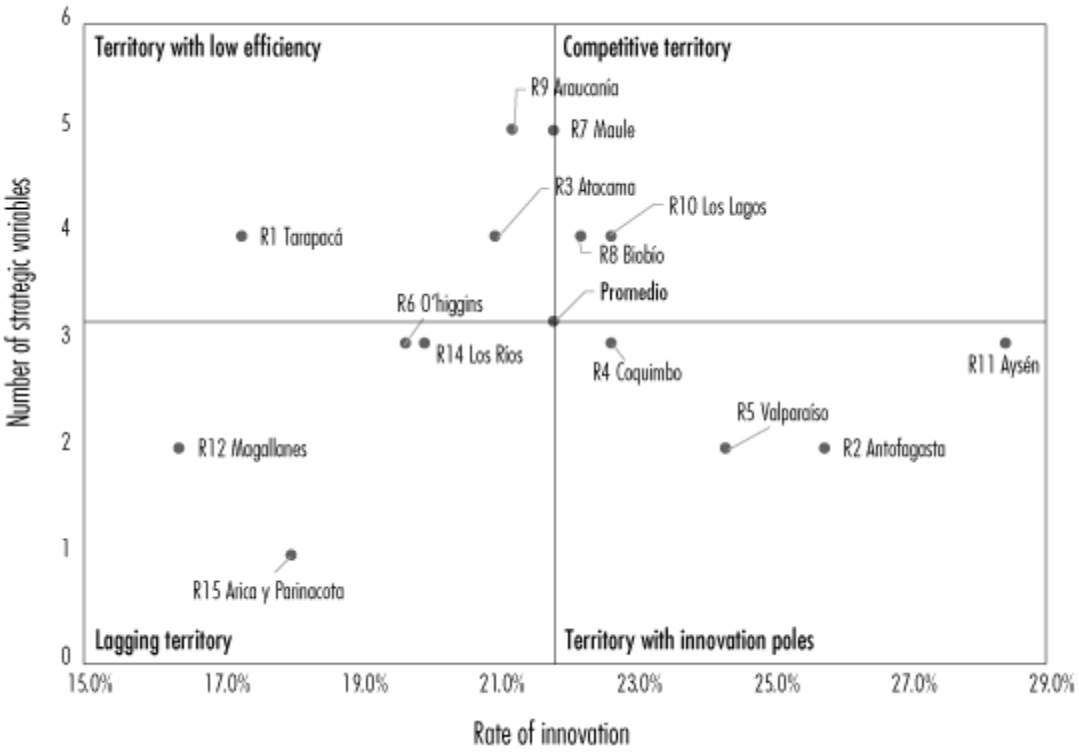
Interregional similarities excluding the national capital

The previous analysis proves the role played by the leadership which the capital represents in a national context. With the aim of seeing the interregional differences clearly a new positional analysis is generated where the metropolitan region is excluded. It is important to note that excluding the national capital does not imply recalculating the different binary logistic regression models (Logit) as they were carried out individually for each region. Furthermore, the determination of regional innovation rates does not present any variances due to the fact that they were calculated individually.

Nevertheless, the exclusion of the national capital changes the average value for the innovation rate, going from 23.6% to 21.8% and the average rate for significant variables shifts from 3.5 to 3.2%.

We have the following positional analysis (see Figure 2), excluding from different quadrants the national capital.

Figure 2. Rate of innovation and significant variables (identifying the quadrants without the metropolitan region)



Source: created by the author based on the results of different Logit models.

- It was proven that there was no region (other than the national capital), which presents a clear leadership in the competitive territory quadrant. The change in average values allows a reclassification of the regions Biobio and Los Lagos, going from low efficiency territory to the quadrant of competitive territory. Nevertheless, in both cases they are very close to the central area of the quadrants
- In the case of the territories with innovation poles we see no major changes. A part that stands out is the shift of the region of Coquimbo, which goes from a lagging territory to that with innovation poles. The principal change is produced by the shift in the average rate of innovation. This case is very close to the central region.
- The other quadrants: the territories with low efficiency and lagging territories do not show any major positional variations at the regional level.

The positional changes seen in the different regions are explained primarily by a reclassification of some of the territories due to a change in the average innovation rate from 23.6% to 21.8%.

5. CONCLUSIONS

The approach used did not focus on innovative efforts, but rather on the environs where they are currently innovating. With this definition, it was proven that 23.6% of the surveyed businesses are innovative at a national level, which is above the expected percentage as Chile is the country from the OECD which spends the least on R&D, investing only .36% of its GDP, while the average is 2.34% (MINECON, 2018).

From the interregional similarity analysis (global and excluding the national capital). The hypothesis of this work was proven: the regions present different conditions and factors which stimulate innovation in businesses. As such, specific public policies are required with regional incentive frameworks in order to reach a harmonious development for the country.

It is interesting the major role that regional R&D has at the moment of explaining the probability that a local business will be innovative. This precedent is important at the moment of decentralizing investments in R&D+i and proposes a new line of work for the new Ministry of Science, Technology, Knowledge, and Innovation (Law 21.105, published 13/08/2018).

It was also proven how insignificant variables associated with scales of production actually are. In few regions do we find significant the following parameters: age, sales, volume of exports, and the quantity of workers, belonging to a business group, among others. The traditional criteria and instruments for classification are not pertinent in order to focus public spending on R&D+i in the territory.

Nevertheless, of significance are the diversity of sources and the possibility for innovation in the future. These variables are mezzoeconomic (intermediate) elements, in particular due to the generation of varied and complex territorial networks, which stimulate innovation. This marks a key methodological aspect at the moment of operating the Ministry of Science, Technology, Knowledge and Technology in the territory, focusing public investments not only in key locations where instruments are found, but rather on incorporating a systemic and more complex logic in the actions of the new Ministry, pointing it towards the articulation of actors and the identification of paths to innovation in regional businesses.

Regarding the low impact of support from the State, there could be two complementary explanations: a temporal discrepancy between the moment of public investment and the innovative result where the state support is at a determined moment (t), which translates into business innovation in the future (t+1) and a misalignment in the criteria for focusing and intervention methodologies.

It is certain that the evidence proves the diversity of situations at a regional level in regards to innovation. As such, it turns out that generating public policies which adapt to the different territories is key, with the following emphasis:

- Territories with low efficiency: regions where the actors in the system of local innovation need to gain focus and collaboration. For these cases, the presence of

technological intermediation offices and of corporations for technological development is of great interest.

- Competitive territories: regions where competition logic can operate by taking advantage of the rivalry between companies in order to stimulate innovation.
- Lagging territories: regions where the state should assume in an active manner the installation of technological skills via the creation of technological centers, attracting advanced human capital, among other alternatives.
- Territory with innovative poles: regions with a necessity for productive (re)articulation in the style of productive clusters. Where it is of fundamental importance to have roundtables or workgroups between the primary businesses, suppliers, and the other local actors surrounding specific projects.

Based on the comparison of interregional similarities, it is proven the clear advantage that the Metropolitan Region (Santiago) has in regards to the innovation rate and the quantity of significant variables. It should be noted that 70% of R&D spending is concentrated in the national capital (MINECON, 2018). It turns out that it is of the utmost importance to have more regions which could assume a position of leadership, passing into the classification of competitive territory. As such, it is urgent to decentralize public spending on R&D at a national level.

The new Ministry should open up the possibility of mixing new approaches and mechanisms for stimulating innovation and promoting productivity. The feasibility of generating innovation based on market stimuli, in the context of a productive cluster (for example: based on export chains) is greater when there are policies which strengthen regional systems by developing new decentralize skills for R&D, concentrating local actor networks in the context of public, private, university, and general partnerships.

BIBLIOGRAPHY

Boix, R., Hervás-Oliver, J. L. and De Miguel-Molina, B. (2015), "Micro geographies of creative industries clusters in Europe: from hot spots to assemblages", *Regional Science*, vol. 94, November. DOI <https://doi.org/10.1111/ pirs.12094>

Breschi, S. and Malerba, F. (1997), "Sectorial innovation systems: technological regimes, shumpeterian dynamics, and spatial boundaries", in Ch. Edquist(ed.), *Systems of innovation technologies, institution and organization,* London, Routledge.

Buesa, M., Heijs, J., Baumert, and Gutiérrez, C. (2015), *Eficiencia de los sistemas regionales de innovación en España,* Fundación de las Cajas de Ahorros (Funcas), Caballero de Gracia, 28, 28013-Madrid, Estudios de la Fundación. Analysis Series, no. 76. Recovered from <https://www.funcas. es/publicaciones/Sumario.aspx?IdRef=5-04078>

Calderón, F. and Castells, M. (2016), "Desarrollo, democracia y cambio social en Chile", in M. Castells and H. Pekka, *Reconceptualización del desarrollo en la era global de la información,* Santiago de Chile, Fondo de la Cultura Económica.

Castells, M. and Hall, P. (1994), *Tecnópolis del mundo: la formación de los complejos industriales del siglo* XXI, Madrid, Alianza Editorial.

Cimolli, M. (2000), *Developing innovation system: Mexico in the global context*, London, Continuum Publishing.

Dallasega, P., Erwin, R. and Linder, Ch. (2018), "Industry 4.0 as enabler of proximity for construction supply chains: a systematic literature review", *Computers in Industry* 99, Elsevier. DOI <https://doi.org/10.1016/j.com- pind.2018.03.039>

Décima Encuesta de Innovación en Empresas 2016 (2018), Instituto Nacional de Estadística de Chile. Recovered from <https://www.economia.gob. cl/2018/02/22/decima-encuesta-de-innovacion-en-empresas-2015-2016. htm>

Dosi, G. (1982), "Technological paradigms and technological trajectories", *Research Policy 11*. DOI <https://doi.org/10.1016/0048-7333(82)90016-6> _____ (1988), "Sources, procedures and microeconomic. Effects of innovation", *Journal of Economic Literature*, vol. XXVI, September. Recovered from <http://venus.unive.it/mvolpe/Dosi%201988.pdf>

European Commission (2017), *Regional innovation scoreboard*. Available at <https://ec.europa.eu/growth/industry/innovation/factsgures/regional_en>

Gatica, F. (2018), "Elementos explicativos de la Innovación en la Industria TIC en Chile", *Revista Interciencia*, vol. 43, no. 6. Recovered from <https:// www.interciencia.net/wp-content/uploads/2018/06/434-GATICA-43_5. pdf>

Gong, H. and Hassink, R. (2017), "Exploring the clustering of creative industries", *European Planning Studies*, vol. 25, no. 4, United Kingdom, Routledge. DOI <10.1080/09654313.2017.1289154>

Hair, J.F, Andersen, R. E., Tathan, R. L. and Black. W. C. (1999), *Análisis Multivariado*, 5th Edition, Madrid, Prentice Hall.

Instituto Nacional de Estadística (INE) (2017), Informe Metodológico de la Décima Encuesta de Innovación. Recovered from <http://www.economia.gob.cl/wp-content/uploads/2018/02/Dise%C3%B1o-Muestral- Innovaci%C3%B3n-2017.pdf>

Ley 21.105 (published August 13, 2018), *Crea el Ministerio de Ciencia, Tecnología, Conocimiento e Innovación*. Recovered from <https://www. leychile.cl/Navegar?idNorma=1121682>

Lundvall, B. A. (1999), "La base del conocimiento y su producción", *Revista Ekonomiaz*, no. 45, Third Quarter. Recovered from <https://dialnet.unirioja.es/servlet/articulo?codigo=265836>

Metcalfe, J.S. (1994), “Evolutionary economics and technology policy”, *The Economic Journal*, 104, July. DOI <https://doi.org/10.2307/2234988>

Ministerio de Economía (MINECON) (2018), “Presentación resultados preliminares VII Encuesta Nacional sobre Gasto y Personal en I+D”. Recovered from <http://www.economia.gob.cl/wp-content/uploads/2018/02/ Beamer_I_D_2016-4.pdf>

Molero, J. (2012), “Factores críticos de la innovación tecnológica en la economía española”, in J. Micheli, E. Medelllin, J. Jasso and A. Hidalgo (coords.), *Innovación y crisis: trayectorias y respuestas de empresas y sectores*, Mexico, Universidad Autónoma Metropolitana-Unidad Azcapotzalco.

Morales, D., Buesa, M., Heijs, J. and Baumert, (2018), “Innovación y competitividad: un análisis aplicado a las empresas industriales españolas”, *Economía y Finanzas Españolas. Cuadernos de Información Económica*, 265, July-August.

Porter, M. E. (1991), *La ventaja competitiva de las naciones*, Buenos Aires, J. Vergara, Editor, S.A.

_____ (2009), *Ser competitivo* (edición revisada y aumentada), Spain, Deusto Ediciones.

Saxenian, A. (2016), “El modelo Silicom Valley: dinamismo económico, exclusión social”, in M. Castells and H. Pekka (coords.), *Reconceptualizando el Desarrollo en la Era de la Información,* Santiago de Chile, Fondo de la Cultura Económica.

Seongsoo, J., Jinwom, K. and Von Zedtwitz, M. (2017), “The importance of spatial, aglomeration, the product innovation: a microgeography perspectiva”, *Journal of Business Research*, vol. 78. Elsevier Inc. DOI <https://doi. org/10.1016/j.jbusres.2017.05.017>

Tidd, J., Bessant, J. and Pavitt, K. (1999), *Managing innovation,* England, John Wiley & Sons.

Villareal. A. and Flores, M. (2015), “Identificación de clusters espaciales y su especialización económica en el sector de innovación”, *Región y sociedad*, año XXVI, no. 62. Recovered from: <http://www.scielo.org.mx/pdf//regsoc/ v27n62/v27n62a5.pdf>