Journal of Evolutionary Studies in Business JESB

Natalia Petelski
Darío Milesi
Vladimiro Verre
Instituto de Industria,
Universidad Nacional de General Sarmiento (Argentina)

Strategies of innovation and appropriation. Sectoral analysis of Argentine manufacturing firms

Abstract

Following the evolutionary and neoshumpeterian theoretical framework, this research studies how the appropriation strategy of firms is formed in different industrial sector and what factors explain the use of the mechanisms that firms use to protect their innovations. The analysis is based on evidence from Argentine manufacturing firms surveyed by the National Survey of Employment Dynamics and Innovation (ENDEI) for 2010-2012. The results of the statistical analysis allow to identify three clusters at the sectoral level with differentiated characteristics in terms of their innovation activities and business conformation. The cluster of high innovative activity shows a greater incidence of the use of secrecy and patents, while the cluster of low innovative activity presents a greater use of complementary assets and first mover. The econometric analysis (Probit models) shows different effects of the factors considered (type of effort and innovative results, capabilities, linkages, structural factors) on the mechanism used, showing that the appropriation strategy is an emerging of innovation process and differs according to the sectoral cluster considered. The type of innovative effort affects only the appropriation strategy of the high and low innovative activity clusters; while the structural factors of firms explain only the appropriation strategy of sectors of high and medium innovative activity.

Corresponding author: e-mail: npetelski@campus.ungs.edu.ar

1. Introduction

Innovation and knowledge are increasingly relevant to explain the economic performance of firms. However, innovation becomes a central competitive element only when the innovator can appropriate its value and associated extraordinary rent. In the face of the threat of possible imitators, he displays what is known in the literature as an appropriation strategy, that is, the use of different legal and strategic mechanisms to protect the market of his innovative product and/or avoid or delay imitation in order to capitalize the benefits derived from its innovation.

From the evolutionary and neoschumpeterian view (Dosi 1982; Pavitt 1984; Winter 1984; Dosi et al. 1994; Freeman 1994; Johnson and Lundvall 1994; Malerba and Orsenigo 1997), it is argued that different sectors show different technological opportunities for innovation and different appropriability conditions, being the capabilities of the firms that operate in these sectors and their strategies who determine who take advantage of such opportunities and benefit from innovation.

Literature little discusses the relationship between innovation/appropriation and the real impact that the perception of appropriation has on the possible efforts of innovators, and there is a certain consensus that private efforts to innovate are made when expectations about private appropriation of benefits from innovation are positive. Most of the appropriation literature are, on the contrary, oriented to the analysis of the mechanisms and strategies that firms use to protect their innovations once they are introduced into the market (Teece 1986; Levin et al. 1987; Harabi 1995; Cohen et al. 2000; Arundel 2001; Galende del Canto 2006; González-Álvarez and Nieto-Antolín 2007; among others).

In this context, the purpose of the paper is to analyze how industrial firms define their appropriation strategy based on the general hypothesis that the appropriation strategy is an

emerging decision of the innovation process, and as such, sectoral cluster to which the firm belongs also affects. Thus, based on a theoretical model that links the characteristics of the innovation process and the different appropriation mechanisms used by the firm, it is sought to identify the factors that explain their choice and whether there are sectoral regularities in the conformation of the appropriation strategy of firms.

The research is based on empirical evidence of Argentine manufacturing firms surveyed by the National Survey of Employment Dynamics and Innovation (hereinafter ENDEI) for the period 2010-2012. A quantitative methodology is followed. First, a cluster analysis is carried out to classify the industrial sectors according to their innovative activity. Through the statistical analysis of the available information, the innovative activity and appropriation strategy of the sectoral clusters are characterized. Then, Probit models are estimated to identify the factors that explain the probability of using the different mechanisms for each of the sectoral clusters and to evaluate how the factors that characterize the innovation process and the structural characteristics of the firms influence the sectoral appropriation strategy.

The document is organized as follows. Section 1 covers the theoretical discussion on appropriability and innovation and introduces the conceptual framework. Section 2 presents the data and the results of the cluster analysis. Section 3 presents the statistical analysis of the innovation and appropriation strategy of the sectoral clusters. Section 4 sets out the methodology for the analysis of the determinants of the sectoral appropriation strategy. Section 5 presents the results of the Probit models. Finally, Section 6 summarizes the main conclusions.

2. Conceptual framework

From the evolutionary and neoschumpeterian view (Dosi 1982; Pavitt 1984; Winter 1984; Dosi et al. 1994; Freeman 1994; Johnson and Lundvall 1994; Malerba and Orsenigo 1997) technological change is determined by the specific opportunities derived from each technological paradigm (Dosi 1982) and their interaction with economic, institutional, organizational, social and political factors. Innovation is conceived as a dynamic and social process, which arises from the interaction and synergies between different types of actors that accumulate capabilities and knowledge through learning processes specific to the agents that own them. In this context, the capabilities of firms and their strategies define who takes advantage of such opportunities and benefits from innovation.

The innovative activity is aimed at differentiating the firm's products and positioning them in the market, to obtain an extraordinary benefit (quasi-rent) based on the privileged position derived from its innovation. However, if the knowledge incorporated into new products and processes can be imitated at a relatively low cost, the remaining benefits may not be sufficient to justify the innovative effort. In this sense, the appropriation literature points out the importance of generating conditions that favor a greater private appropriability, in order to stimulate investment in R&D, justifying regulation through intellectual property rights (IPR) as a necessary condition to invest in innovation. This line of thinking is based on Arrow's (1962) approach about the existence of market failures, caused by uncertainty about the results of innovative efforts and about the private appropriation of the benefits of innovation, which lead to a lower investment in innovation by comparison with the socially desirable.

However, the theoretical discussion about the real impact that the perception of appropriation has on innovative efforts is not completely resolved. Other authors assign a lower role to appropriability as an incentive for technological innovation and argue that innovation efforts depend more on the capabilities and strategies of the firms than on the conditions of appropriation of the results of such efforts (Geroski 1995; Klevorick et al. 1995; Veugelers and Cassiman 1999). In the same direction, Dosi et al. (2006) argue that minimum conditions of appropriability are necessary to encourage innovation, but after companies reach a certain minimum threshold in their perception of appropriation, further strengthening of these conditions does not determine a significant increase in investment in R&D or in innovation rates. These define the position that supports this work, since as we have pointed out, it based on the general hypothesis that the appropriation strategy is an emerging decision of the innovation process. In Milesi et al. (2014), the authors point out a certain contradiction in Arrow's approach, since on the one hand, a regulatory mechanism is proposed arguing that the innovation process is intrinsically uncertain and, on the other, an IPR scheme is suggested that ensures the appropriation of an innovation that the potential innovator, by the same argument, has not any certainty of obtaining.

Parallel to this theoretical debate a more empirical literature has mostly focused on identifying the mechanisms used by firms to protect and appropriate the benefits of innovation once it has been obtained (Teece 1986; Levin et al. 1987; Harabi 1995; Cohen et al. 2000; Arundel 2001; Galende del Canto 2006; González-Álvarez and Nieto-Antolín 2007; among others). The main mechanisms of appropriation can be classified into two broad categories: on the one hand the legal ones, which include the patent (or license, when the owner of the patent yields the right of its exploitation), the utility models and the

industrial/design models; and on the other hand the strategic ones, especially complementary assets, industrial secret and first mover. The ***patent*** is a legal provision by which the inventor of a new device or process is assigned an exclusive (temporary) right over the production or use of it (Griliches 1990). The literature notes that the information that firms must disclose when publishing the patent (disclosure) allows competitors to legally innovate "around" that patent, this risk of copying is greater in process innovation (Levin et al. 1987; Cohen et al. 2000; Blind et al. 2006). The ***utility model*** is a right granted to a new form obtained in a known object that implies a better use in its function. The ***industrial/design model*** is rights granted to protect the original and ornamental features that derive from the design activity. This mechanism does not protect the functionalities of the products. The ***complementary assets*** is a concept introduced by Teece (1986) to highlight its importance as a strategic appropriation mechanism, emphasizing the fact that their possession or not determines the distribution of the benefits of innovation and market power. Teece identifies both productive assets (competitive manufacturing, scale, quality, etc.) and commercial assets (distribution channels, marketing, after-sales services and complementary technologies). The ***industrial secret*** is the adoption of means or systems to preserve confidentiality and restrict access to relevant technological information (CEP 2006). The literature finds that this mechanism is more effective to protect process than product innovations, given the risk of imitation through reverse engineering (Harabi 1995; Arundel 2001; Fernández Sánchez 2004). The ***first mover*** is the strategy of introducing a product/service to the market before the competitor, in order to obtain a temporary advantage (temporary monopoly) that allows the innovative firm to appropriate the benefits of its innovation. In relation to this strategy, it is necessary to differentiate between those firms that launch an innovation that materializes a new concept of

those firms that are moving based on successive incremental innovations, the latter being the way in which this mechanism is mostly used in developing countries (Levin et al. 1987; Lieberman and Montgomery 1988; Fernández Sánchez 2004; Galende del Canto 2006; González-Álvarez and Nieto-Antolín 2007)[1].

Given the diverse characteristics and spaces of effectiveness of the different appropriation mechanisms, firms usually use them simultaneously and in a complementary way (Hurmelinna-Laukkanen and Puumalainen 2007; Laursen and Salter 2005) forming what is known in the literature as "strategy of appropriation" (Cohen et al. 2000). The literature finds that the use and effectiveness of appropriation mechanisms vary according to the industrial sector (Mansfield 1986; Levin et al. 1987; Arundel and Kabla 1998; Brouwer and Kleinknecht 1999; Cohen et al. 2000; Neuhäusler 2012; Hurmelinna-Laukkanen et al. 2016; Paula and Da Silva 2019). Several empirical studies that analyze the use of appropriation mechanisms, mostly oriented to the study of patents, also point out differences according to the size of firms (Levin et al. 1987; Arundel and Kabla 1998; Brouwer and Kleinknecht 1999; Cohen et al. 2000; Combe and Pfister 2000; Arundel 2001; Sattler 2003; Chabchoub and Niosi 2005; Blind et al. 2006; Hanel 2006; Byma and Leiponen 2007; Leiponen and Byma 2009; Neuhäusler 2012; Holgersson 2013; Milesi et al. 2013; Paula and Da Silva 2019; among others); ownership of the capital of the firm (Arundel 2001; Cincera 2005; Hu and Jefferson 2005; López and Orlicki 2007; López 2009; Neuhäusler 2012); the exporting condition of the firm (Arundel and Kabla 1998; Hurmelinna-Laukkanen et al. 2016); public financing for R&D (Cincera 2005); R&D cooperation (Brouwer and Kleinknecht 1999;

---

[1] For a more detailed description of each appropriation mechanism, see Milesi et al. (2017).

Arundel 2001; Leiponen and Byma 2009; Milesi et al. 2017), although without reaching conclusive results on the impact of such factors.

The sectoral consideration pointed out by the evolutionary and neoschumpeterian view and by the empirical works of use of mechanisms constitutes a central dimension of analysis in the present investigation. Therefore, in Section 2 below, a classification of the industrial sectors is carried out using the technique of cluster analysis; in order to characterize and compare the innovation and appropriation strategies of firms according of their sectoral clusters of belonging. The others characteristics of the firms mentioned by the empirical studies of appropriation (size, ownership of the capital, the exporting condition, public financing for R&D and R&D cooperation) are taken into consideration in section 4.2 to define the set of indicators used for the econometric analysis.

3. Data

The research is based on data collected by the National Survey of Employment Dynamics and Innovation (ENDEI) carried out by the Ministry of Science, Technology and Productive Innovation (MINCyT) and the Ministry of Labor, Employment and Social Security (MTEySS) of Argentina. The ENDEI has a national scope, covers all industrial sectors, is representative of firms with 10 or more employees and provides information regarding the 2010-2012 period. The ENDEI base is composed of 3691 companies and reports firm's economic activity at two digits according to the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 3).

The technique of cluster analysis is applied to classify sectors acording to their innovative activity, in order to study the characteristics of each of these groups and identify if there are

sectoral regularities in the conformation of the appropriation strategy of firms. The grouping of industrial sectors is based on three types of technological indicators. First, the firm's decision to invest or not in different types of innovation activities, calculated by the percentage of firms in the industrial sector that invest in each type of innovation activities (internal R&D, external R&D, industrial design and engineering, machinery and equipment, hardware and software, training, technology transfer, consulting). Second, the intensity of such investments in relation to current income, calculated by the average for each industrial sector of the participation of the firm's expenditure in different types of innovation activities in relation to its current income. Finally, the structure or composition of investments in innovation, in order to capture how firms distribute their total investment in innovation activities (sectoral average proportion of each type of investment). The cluster analysis uses the K-means method (K=3), suitable for quantitative variables, calculating the measure of distance or similarity between cases by means of the Euclidean distance without standardization (since all variables are measured as percentage and are thus on a 0-1 scale).

Table 1 below shows the sector grouping that the cluster analysis yields. It can be seen that the cluster 1 groups the most knowledge intensive industrial sectors such as chemistry, medical instruments, oil production and various types of machinery and equipment. On the other hand, more capital-intensive sectors such as automotive and transportation equipment, metal fabrications, non-metallic minerals and rubber and plastic products are grouped in cluster 2. Finally cluster 3 groups those branches of mass consumption, more intensive in labor and natural resources, such as food and beverages, textile products, apparel, leather, wood, furniture, paper and publishing.

Table 1. Classification of sectors according to the cluster analysis

INNOVATIVE ACTIVITY					
Cluster1		Cluster2		Cluster3	
Sectors*	firms	Sectors*	firms	Sectors*	firms
24 = Chemical products	317	25 = Rubber and plastics products	192	15 = Food products and beverages	734
29= Machinery and equipment	402	26 = Other non-metallic mineral products	130	17 = Textile products	198
30 = Office, accounting and computing machinery	135	27 = Basic metals	129	18 = Wearing apparel	146
33= Medical instruments	79	28 = Other metal products	228	19 = Leather	135
99 = Rest (oil; other machinery and electrical equipment; tobacco)	86	34 = Motor vehicles, trailers and semi-trailers	171	20 = Wood	131
		35 = Other transport equipment	74	21 = Paper	135
				22 = Publishing	136
				36 = Forniture; manufacturing industry n.e.c.	133
Total firms	**1,019**		**924**		**1,748**

Note: *ISIC Rev. 3 two digits
Source: Own elaboration

Table 2 characterizes each sectoral cluster according to five dimensions. On the one hand, it can be observed that all clusters are similar in terms of size (mostly SMEs) and age (majority of older firms). On the other hand, the clusters are different in terms of ownership of capital and market orientation. Cluster 1 shows the highest percentages of multinationals,

corporations and exporters while, opposite to it, cluster 3 shows the lowest proportion in all three dimensions. Somewhere in between is cluster 2 with percentuals similar to the whole data base average.

Table 2. Characterization of sectoral clusters

Firms	Cluster 1 (%)	Cluster 2 (%)	Cluster 3 (%)	Total (%)
SMEs*	80.0	78.7	80.0	79.7
Age**	23.3	23.2	29.7	26.3
Multinational	14.2	9.5	6.1	9.2
Corporations	16.2	11.7	10.4	12.3
Exporter	56.5	38.3	28.8	38.9

Note: * Less than 100 employees; ** 10 or less years old
Source: ENDEI 2010-2012.

4. Innovation strategy and appropriation of sectoral clusters

In order to characterize and compare the innovation strategy of the sectoral clusters identified in the previous section, Table 3 shows for each cluster, the average percentage of firms in each industrial sector that invest in different types of innovation activities. It is observed that cluster 1 forms the group of high innovative activity, showing an average of 76.6% of firms that invest in innovation. The percentage is higher also considering the different allocation. Although the acquisition of machinery and equipment is the main use of the innovation investment (62.8%), the greatest relative difference among clusters occurs in internal R&D, with 58% of the firms of cluster 1 spending on that innovation activity, against 40.7% of cluster 2 and 30% of cluster 3. Cluster 2, meanwhile, shows intermediate values in the percentage of firms that invest in innovation, about 67.6% on average, showing a percentage

closer to cluster 1 in the case of industrial design and closer to cluster 3 considering the expense in technology transfer. Finally, cluster 3 is considered of low innovative activity, with almost 59% of the firms that invest in innovation activities on average, strongly prevailing the machinery and equipment allocation (52.7%).

Table 3. Percentage of firms that invest in different types of innovation activities

Type of innovation investment	Cluster			Total firms (%)
	Cluster HIGH (%)	Cluster MEDIUM (%)	Cluster LOW (%)	
Total Innovation Activities	76.6	67.6	58.9	66.0
Internal R&D	58.0	40.7	29.8	40.3
External R&D	26.1	18.8	13.3	18.2
Industrial Design	51.3	43.7	24.5	36.7
Machinery & Equipment	62.8	59.5	52.7	57.2
Hardware & Software	45.9	39.7	33.3	38.4
Training	48.2	41.2	32.4	39.0
Technology Transfer	16.5	8.9	7.9	10.5
Consultancy	41.2	35.0	26.3	32.6

Source: Own elaboration based on ENDEI 2010-2012.

Considering the average intensity of the innovation investment, measured as the expense in different types of innovation activities in relation to the current income of the firm, Table 4 shows that in aggregate terms there is not difference between the three clusters, which allocate approximately 3.3% of their current income to investment in innovation. The main difference is observed in the allocation of it. Although in all cases the greatest effort in innovation is oriented to the acquisition of machinery and equipment, the sectors of cluster 1 show a greater

relative intensity in R&D (0.95%), mainly internal but also external, and industrial design and engineering (0.4%), highlighting the complementarity between the acquisition of incorporated technology and the generation of knowledge; while in the case of cluster 2 and 3, the intensity in machinery and equipment (2.7%) strongly predominates over the other allocations.

Table 4. Intensity of investment in different types of innovation activities

Type of innovation investment	Cluster			Total firms
	Cluster HIGH	Cluster MEDIUM	Cluster LOW	
Innov.Act /Current-Income	**0.0331**	**0.0345**	**0.0334**	**0.0336**
I+D Total/Current-Income	**0.0095**	**0.0045**	**0.0029**	**0.0051**
Int.R&D/Current-Income	0.0087	0.0036	0.0024	0.0045
Ext.R&D/Current-Income	0.0017	0.0013	0.0008	0.0012
Ind.Design/Current-Income	0.0040	0.0036	0.0013	0.0026
Mach & Equipment/Current-Income	0.0177	0.0268	0.0268	0.0243
Hard & Soft/Current-Income	0.0012	0.0011	0.0009	0.0010
Tech.Transfer/Current-Income	0.0019	0.0004	0.0004	0.0008
Training/Current-Income	0.0007	0.0006	0.0004	0.0005
Consultancy/Current-Income	0.0017	0.0013	0.0010	0.0012

Source: Own elaboration based on ENDEI 2010-2012.

This last result is also reflected when considering the composition of the distribution of total innovation expenditures as Table 5 shows. The sectors that form the cluster 1 show a more homogeneous distribution of innovation spending, allocating 41.7 % to machinery and equipment, 23.4% to internal R&D and almost 12% to industrial design. On the contrary, in those sectors of medium and low innovative activity, the acquisition of machinery and equipment predominates, by allocating 56.5% and 66.5% respectively of their total innovation

investment to that use. However, although to a lesser extent, the cluster 2 of medium innovative activity is closer to the high cluster when considering R&D activities (internal and external) and industrial design.

Table 5. Distribution of total innovation expenditure in their different allocations

Type of innovation investment	Cluster			Total firms
	Cluster HIGH	Cluster MEDIUM	Cluster LOW	
Int.R&D/Innov.Act	0.234	0.134	0.089	0.140
Ext.R&D/Innov.Act	0.040	0.031	0.026	0.031
Ind.Design/Innov.Act	0.119	0.097	0.039	0.076
Mach & Equipment/Innov.Act	0.417	0.565	0.665	0.571
Hard & Soft/Innov.Act	0.065	0.073	0.083	0.076
Tech.Transfer/Innov.Act	0.023	0.012	0.010	0.014
Training/Innov.Act	0.030	0.020	0.023	0.024
Consultancy/Innov.Act	0.072	0.066	0.064	0.067

Source: Own elaboration based on ENDEI 2010-2012.

Considering the obtaining of product and/or process innovations, Table 6 below shows that 71.2% of the firms in cluster 1 have innovated in the analyzed period, while the percentage of innovative firms reach 62.1% considering the sectors of cluster 2 and 54.4% in the case of cluster 3. Taking into account the type of innovation, the data indicate that although in the three clusters it is majority the number of firms that obtain simultaneously product and process innovations, the incidence of firms that innovate only in process increases as we mover from cluster 1 to cluster 2, and from the latter to cluster 3, highlighting that in sectors of less innovative activity, although product innovations predominate, it becomes more important the process innovations. The cluster of high innovative activity also shows a greater

participation of firms that obtained commercialization (23.3%) and organizational (26.8%) innovations, the latter being superior in the three sectoral clusters.

Table 6. Percentage of innovative firms by type of innovation

Firms	Cluster		
	Cluster 1 HIGH (%)	Cluster 2 MEDIUM (%)	Cluster 3 LOW (%)
Innovative*	71.2	62.1	54.4
Only Product**	19.3	15.2	13.4
Only Process**	10.6	11.1	12.5
Product&Process**	70.1	73.7	74.1
Organizational *	26.8	24.5	20.5
Commercialization *	23.3	17.1	18.8

Note: (*) % calculated on total firms of the cluster. (**) % calculated on the total of innovative firms in product and/or process of the cluster.
Source: Own elaboration based on ENDEI 2010-2012.

In summary, the analysis of the innovation strategy shows that, although in aggregate terms the Argentine manufacturing firms analyzed have invested approximately 3.3% of their current income in innovation activities between 2010-2012, the sectors identified as high innovative activity are characterized not only by a greater number of firms that carry out innovations activities of all types, but also they have distributed the funds more homogeneously by combining the acquisition of machinery with investment in R&D. On the contrary, in those sectors of medium and low innovative activity the acquisition of machinery and equipment predominates strongly. This translates into a higher proportion of innovative firms in the case of cluster 1 (71.2% versus 54.4% observed in cluster 3); and although more than 70% of the innovative firms in each of the clusters obtained simultaneous product and

process innovations, the incidence of process innovations is greater in the cluster of medium and low innovative activity, which mainly include intensive capital and mass consumption sectors, respectively.

Considering the appropriation strategy of innovative firms in product and/or process, the vast majority of Argentine manufacturing firms have use at least one appropriation mechanism to protect their innovations in the 2010-2012 period (87.1% of cluster 1; 84.4% of cluster 2 and 83.4% of cluster 3).

Figure 1. Number of appropriation mechanisms used by sectoral cluster (% cluster firms)
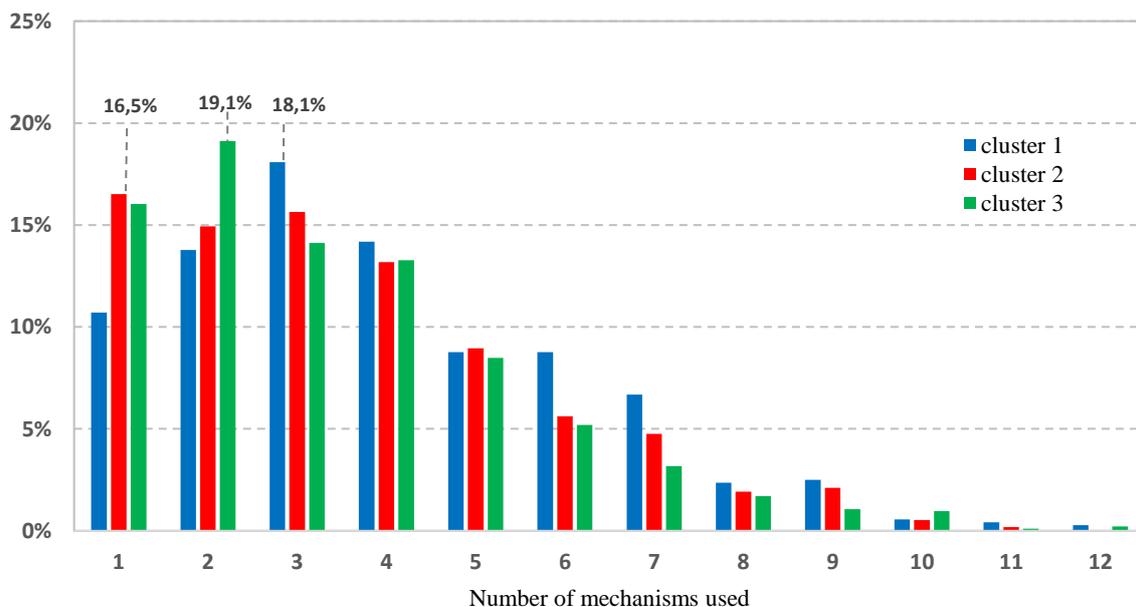
Source: Own elaboration based on ENDEI 2010-2012.

Figure 1 shows the percentage of firms of each sectoral cluster that uses different amounts of appropriation mechanisms to configure its appropriation strategy. It is observed that cluster 1 seems to show greater diversification in the use of appropriation mechanisms, since the number of firms that simultaneously use three mechanisms (18.1%) predominates, being also

considerable the number of firms that use between six and seven (8.8% and 6.7% of the firms in cluster 1 respectively). Cluster 2 of mediam innovative activity is mostly identified with the use of a single appropriation mechanism (16.5%) and almost half of the firms that form this sectoral cluster rely on only three mechanisms. Finally, cluster 3 shows a conformation similar to that observed by cluster 2, although it mostly relies on two mechanisms (19.1%).

Figure 2 shows that the appropriation strategy of Argentine manufacturing firms relies mainly on the use of their complementary assets (productive and commercial), since more than 80% of the firms that form each of sectoral clusters have protected the innovations of the analysed period through this mechanism. Considering the instruments included in this type of mechanism, it is more widely used the active communication with customers (reaching 69.1% of the firms in cluster 1 and 62.1% of cluster 3) and the production scale (between 43% and 47% according to the cluster). The comparison among clusters highlights the greater relative use of the production scale and distribution networks in the case of the low innovative activity cluster, as expected taking into account the sectors that form it. Another difference among clusters is manifested in the use of secrecy, which in the analysis includes not only technological secrecy, as generally is considered by the literature, but also its use in relation to the firm's human resources (confidentiality contracts). The secrecy is more used in firms with high innovative activity (46.6%), which incidence is well above that observed for the sectors that form the cluster of low innovative activity (29.5%) and practically doubling the incidence of use of this mechanism in the case of medium innovative activity sectors (21.1%). For the rest of the mechanisms analyzed, the incidence of use is reduced as one passes to clusters of less innovative activity, with the only exception of the utility model, which is

higher in the case of cluster 2. This would indicate a correlation between the level of innovative activity and the use of mechanisms to protect innovations.

Figure 2. Type of appropriation mechanisms used by sectoral cluster (% cluster firms)
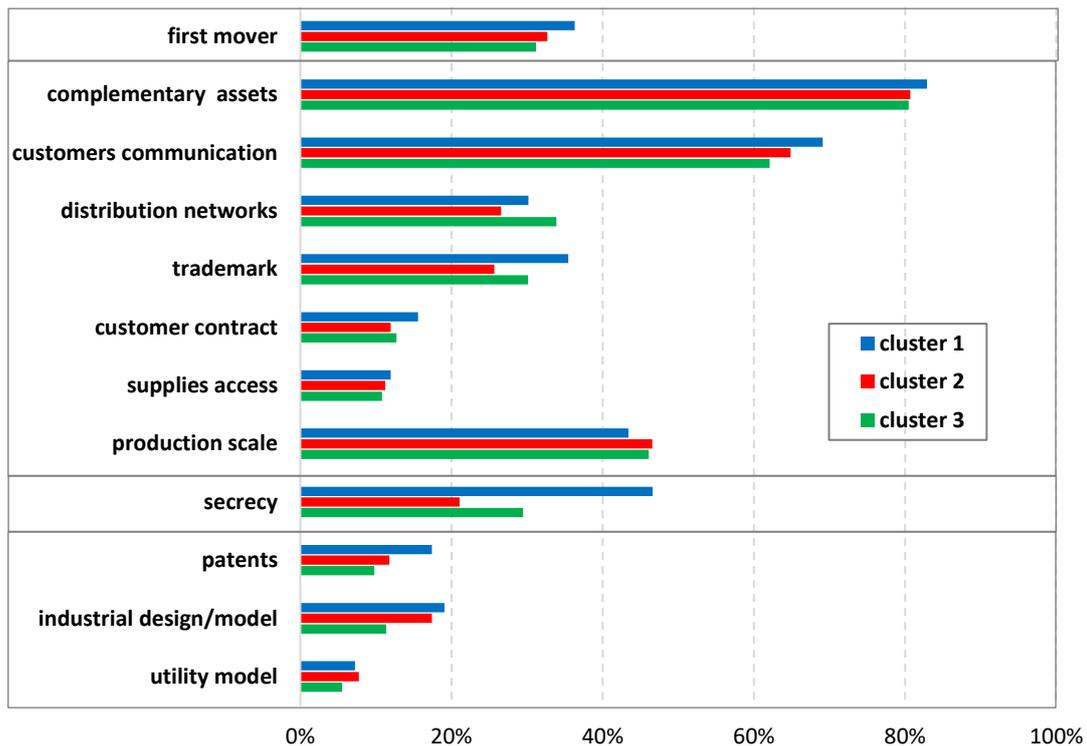
Source: Own elaboration based on ENDEI 2010-2012.

Finally, it is interesting to analyze which cluster shows a greater relative use of each mechanism. Figure 3 below groups the different complementary assets (productive and commercial) and considers only the patents among the legal assets for being the instrument of greatest use within this group. The data clearly differentiate the appropriation strategy of the cluster of high and low innovative activity; since considering the total number of firms that use patents and secrecy, the sectors that form the high innovative activity cluster predominate (44% and 43.9% respectively), while on the contrary, considering the total number of firms

that use complementary assets and first mover, most of them belong to sectors included in the cluster of low innovative activity (41.8% and 39.7% respectively).

Figure 3. Use of appropriation mechanisms according to sectoral cluster
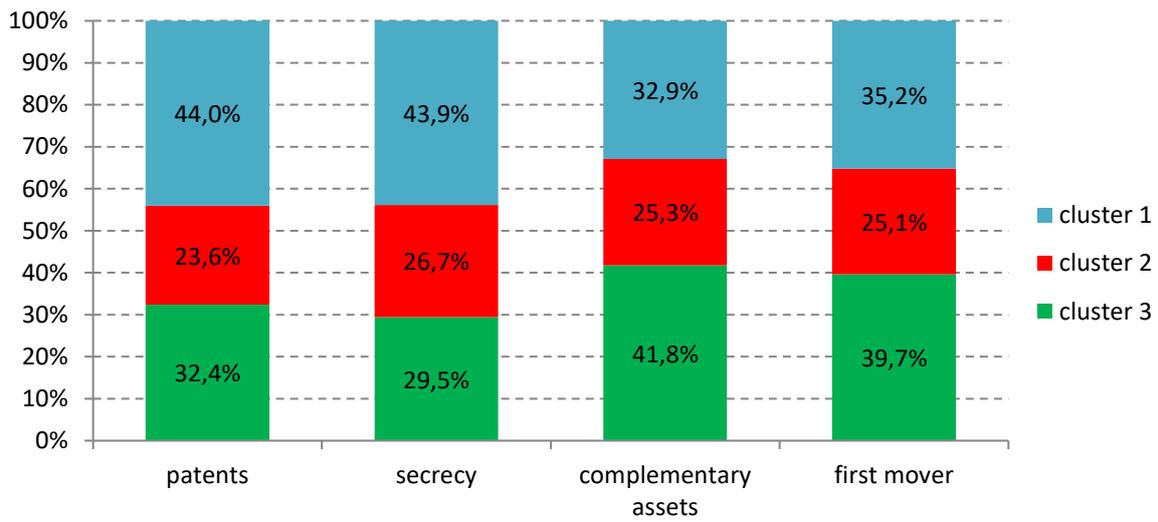
Source: Own elaboration based on ENDEI 2010-2012.

In this way, the appropriation strategy analysis shows that complementary assets are the most widely used appropriation mechanism in the case of the analyzed industrial manufacturing firms, regardless of their industrial sector. Within this type of mechanism, active communication with customers (customer loyalty) becomes more relevant, with greater incidence in cluster 1, and the production scale, mostly in cluster 2 and 3. The cluster of high innovative activity is characterized for combining a greater number of mechanisms to configure its appropriation strategy, also showing a greater incidence of use of secrecy; while it forms the cluster with the greatest presence within the total firms that patent. On the contrary, the cluster of low innovative activity is majority when considering the total firms that use the complementary assets and first mover.

5. Methodology for the analysis of the determinants of the sectoral appropriation strategy

5.1. Model Specification

In order to study what factors impact to the conformation of the sectoral appropriation strategy, Probit models (or the alternative, logit models) can be proposed to explain the probability of use of each mechanism, which are estimated for firms belonging to the sectors that form each cluster.

The model specification is as follows:

$$y = \begin{cases} 1 \text{ with probability } p, \\ 0 \text{ with probability } 1 - p \end{cases} \qquad p_i \equiv Pr[y_i = 1 \mid x\,] = F(x_i' \beta)$$

where F $(\cdot)$ is a cumulative distribution function in order to ensure that $0 \le p \le 1$, being in the case of the Probit Models estimated in the present investigation the cumulative distribution function of the Standardized Normal (Greene 2003).

5.2. Indicators

Table 7 summarizes the indicators used for the econometric analysis. The explained variables are binary, and take value 1 if the firm has used the mechanism considered to protect its product and/or process innovations for the 2010-12 period. Among the legal mechanisms only patents are analyzed, given that the small percentage of utilization of industrial design/model and utility models does not allow the econometric estimation. The patent variable (PAT), considers both the firms that have patented and those that have patents in process during the period. Among the strategic mechanisms, secrecy (SEC) takes into account both the use of technological secrecy and refered to human resources, as previously mentioned.

Complementary assets (ASS) include productive and commercial mechanisms. Finally, first mover or to reach the market first (MOV) mechanism is analyzed.

Among the explanatory variables, the model includes variables that reflect the innovative behavior of the firm in terms of investments (type of innovation expenditure) and results (type of innovative result), following what was stated in the initial discussion about the emerging nature of the appropriation strategy, which is defined based on the path of the innovation process itself. The paper distinguishes among three types of innovation activities that firms can carry out: the generation of technology, which contemplates the cases in which firm invested in R&D and/or industrial design and engineering (binary variable RDE); the acquisition of incorporated technology, which capture the investment in machinery and equipment, hardware and software (INCTEC); and the acquisition of disembodied technology, which takes into account technology transfer, training and consulting (DISTEC). The results of the innovative process are measured from binary variables that indicate whether the firm has achieved product (PROD), process (PROC), organizational (ORGAN) or commercialization (COM) innovations during the analyzed period.

The potential capacity of firms to innovate is approximated through a continuous variable (PROF) that measures the proportion of engineers and professionals in the total employees of the firm, seeking to capture the accumulated technological skills. A binary variable is also incorporated to indicate whether the firm has a department or formal R&D area (RDDEP). The links with other agents to innovate and the use of external sources of knowledge are also considered in the model. It is distinguished, on the one hand, if the firm is linked to other firms (LINKF) to jointly carry out innovation activities (R&D, technological exchange, testing and research trials, development or improvement of products/processes, industrial

design and engineering); and on the other hand, if the firm is linked to these innovation activities with universities (public and/or private) and public institutions of science and technology (S&T) (LINKU). The firm's access to public financing for innovation, through innovation oriented support programs or human resources training (PUBS) is also considered.

Table 7. Indicators

Indicators	Description	Variable
PAT	Use of patents	Binary
SEC	Use of secrecy	Binary
ASS	Use of complementary assets	Binary
MOV	Use of first mover	Binary
RDE	Investment in R&D and/or industrial design and engineering	Binary
INCTEC	Investment in machinery and equipment, hardware and software	Binary
DISTEC	Investment in technology transfer, training and consulting	Binary
PROF	Proportion of engineers and professionals in the total employees	Continuous (0/1)
LINKF	Link to other firms	Binary
LINKU	Link with universities and public institutions of S&T	Binary
PUBS	Firm benefited with public support to innovation	Binary
RDDEP	Firm with formal R&D area or department	Binary
PROD	Innovation of product	Binary
PROC	Innovation of process	Binary
ORG	Innovation organizational	Binary
COM	Innovation of commercialization	Binary
SIZE	Logarithm of total number of employees	Continua
AGE	Young company: 10 years or less of age	Binary
MNC	Firm with foreign capital participation	Binary
GROUP	Firm belonging to an economic group of companies	Binary
X	Exporting Firm	Binary
Sectoral Dummies	Dummies indicating the industrial sector (D1 to D18)	Binary

Source: Own elaboration based on ENDEI 2010-2012.

Finally, among the structural characteristics of the firms, it is considered the firm size by a continuous variable (SIZE) that measures the number of employees (in logarithmic scale); the age by a binary variable (AGE) that takes value 1 to indicate a young company (10 years or less); the ownership of capital by a binary variable (MNC) that indicates that the firm is multinational; the belonging to a group of companies controlled by a holding (binary variable GROUP); and the market orientation by a binary variable that indicates that the firm is an exporter (X). The industrial sector to which the firm belongs is controlled by a dummy variable (according to ISIC Rev. 3 two digits).

6. Results of the econometric analysis

For the econometric analysis, the sample of firms is divided according to their sectoral cluster, estimating the Probit models for each mechanism at the firm level within each cluster. Table 8 shows the results for the industrial sectors that form the cluster 1 of high innovative activity (chemical and medical instruments, the production of oil and various types of machinery and equipment), Table 9 for cluster 2 of medium innovative activity (automotive and transport equipment, metal fabrications, non-metallic minerals and rubber and plastic products) and Table 10 for cluster 3 of low innovative activity (food and beverages, textile products, apparel, leather, wood, furniture, paper and publishing).

The results are analyzed by a double direction. On the one hand, comparing between clusters (vertical analysis) to identify sectoral specificities in the factors that explain the use of each particular mechanism (summarized in Tables 11 to 14). On the other hand, as a synthesis of these results and to highlight the sectoral differences, comparing the results within each cluster, in order to identify the differentiated impact of the innovative process and structural factors in the use of the different mechanisms (horizontal analysis).

Table 8. Probit Models: CLUSTER 1

Explanatory variables (X)	**PATENTS** F=Pr(PAT=1) dF/dX (a)		**SECRECY** F=Pr(SEC=1) dF/dX (a)		**COMP. ASSETS** F=Pr(ASS=1) dF/dX (a)		**FIRST MOVER** F=Pr(MOV=1) dF/dX (a)	
RDE	0.0532		0.0992		0.0439		0.1584	**
INCTEC	0.0376		0.0723		-0.0468		-0.1465	**
DISTEC	0.0064		0.0977	*	0.0406		0.0772	
PROF	0.1519		0.4585	***	0.0784		0.1515	
LINKF	-0.0120		-0.0322		0.0249		-0.0076	
LINKU	0.0674	**	0.1943	***	0.0389		0.0383	
PUBS	-0.0036		-0.1315		0.0035		0.0224	
RDDEP	0.0428		0.1217	**	0.0105		0.1480	***
PROD	0.0338		0.2261	***	0.2658	***	0.1929	***
PROC	-0.0680	*	-0.0093		0.0883	**	-0.0389	
ORG	0.0235		0.0138		0.0605	**	0.0579	
COM	0.0585	*	0.0691		0.0847	***	0.0314	
SIZE	0.0489	***	0.0064		0.0305	*	0.0043	
AGE	0.0006		-0.0399		0.0192		-0.0796	*
MNC	-0.0165		0.0594		0.0163		-0.0022	
GROUP	-0.0445		0.0241		-0.0334		-0.0664	
X	0.0126		0.0285		-0.0044		-0.0068	
Sectoral Dummies	included		included		included		included	
Observations	697		697		697		697	
Pseudo R2	0.1105		0.1457		0.1489		0.0771	
Chi2	70.42 (0,00)		140.39 (0,00)		94.89 (0,00)		70.50 (0,00)	
Log Likelihood	-283.34798		-411.47548		-271.11605		-421.92472	
Prediction	83.79%		69.44%		82.93%		68.15%	

(a) marginal effect, ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table 9. Probit Models: CLUSTER 2

Explanatory variables (X)	PATENTS F=Pr(PAT=1) dF/dX (a)		SECRECY F=Pr(SEC=1) dF/dX (a)		COMP. ASSETS F=Pr(ASS=1) dF/dX (a)		FIRST MOVER F=Pr(MOV=1) dF/dX (a)	
RDE	0.0282		0.0892		0.0462		0.0228	
INCTEC	0.0411		-0.1449		-0.0638		-0.0385	
DISTEC	-0.0414		-0.0718		0.0438		-0.0245	
PROF	0.2860	**	0.1562		-0.6642	***	0.0275	
LINKF	-0.0063		0.0413		-0.01189		0.0072	
LINKU	0.03769		0.1725	***	0.0697	*	0.03452	
PUBS	-0.0436		-0.0098		0.0579		0.0576	
RDDEP	0.1305	***	0.0884		0.1092	**	0.0973	
PROD	0.0570		0.1572	**	0.2165	***	0.1297	*
PROC	-0.0323		0.1724	***	0.0987	*	-0.0555	
ORG	0.0140		0.0727		-0.0594		0.1330	***
COM	0.0222		-0.0375		0.0883	**	0.0353	
SIZE	0.0181		0.0050		-0.0177		0.0076	
AGE	-0.0319		0.0272		0.0096		0.0351	
MNC	-0.0348		0.0033		0.0904		-0.0418	
GROUP	0.0895	*	0.0471		-0.0946		0.0718	
X	0.0486	*	0.0949	**	0.0408	*	0.0894	**
Sectoral Dummies	incluidas		incluidas		incluidas		incluidas	
Observations	552		552		552		552	
Pseudo R2	0.2117		0.0925		0.1137		0.0830	
Chi2	85.54 (0,00)		66.84 (0,00)		61.07 (0,00)		58.29 (0,00)	
Log Likelihood	-159.2925		-327.99694		-238.03395		-322.20969	
Prediction	89.49%		68.66%		81.34%		67.75%	

(a) marginal effect, ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table 10. Probit Models: CLUSTER 3

Explanatory variables (X)	PATENTS F=Pr(PAT=1) dF/dX (a)		SECRECY F=Pr(SEC=1) dF/dX (a)		COMP. ASSETS F=Pr(ASS=1) dF/dX (a)		FIRST MOVER F=Pr(MOV=1) dF/dX (a)	
RDE	0.0301		0.1244	***	0.0556	*	0.0557	
INCTEC	0.0099		-0.0137		0.0426		0.0416	
DISTEC	0.0159		0.0580		0.0852	***	0.0079	
PROF	0.1497	*	0.1704		0.1829		-0.0150	
LINKF	-0.0172		0.0243		0.0224		0.0623	*
LINKU	0.0156		0.0900	***	0.0354		0.0447	
PUBS	-0.0141		-0.0669		0.0546		0.1147	
RDDEP	0.0736	***	0.1069	**	0.0254		0.1382	***
PROD	0.0348		0.1722	***	0.1575	***	0.2866	***
PROC	0.0029		0.0232		-0.0247		0.0381	
ORG	-0.0065		0.0519	*	0.0003		0.0454	
COM	0.0686	***	0.0459		0.1225	***	0.0851	**
SIZE	0.0082		0.0190		-0.0047		0.0091	
AGE	0.0241		0.0032		0.0458		0.0654	*
MNC	0.0198		0.0947		-0.0081		0.0143	
GROUP	0.0019		-0.0499		0.0060		0.1328	**
X	0.0209		0.0418		0.0038		-0.0041	
Sectoral Dummies	incluidas		incluidas		incluidas		incluidas	
Observations	904		904		904		904	
Pseudo R2	0.1259		0.1501		0.1131		0.1316	
Chi2	71.54 (0,00)		148.86 (0,00)		100.52 (0,00)		147.66 (0,00)	
Log Likelihood	-248.31461		-421.47527		-393.94525		-487.23654	
Prediction	90.60%		77.1%		81.08%		71.79%	

(a) marginal effect, ***Significant at 1%; **Significant at 5%; *Significant at 10%

Considering the patents, it is observed that the realization of efforts in innovation does not affect its probability of use in any of the sectoral clusters. In the case of medium and low innovative activity cluster its use is associated with the capabilities of the firms and formal

research; since a 10% increase in the proportion of qualified employment raises the probability of use of patents by 28.6% in the sectors of cluster 2 and 15% in the case of cluster 3; while having a department or formal R&D area increases the probability by 13.1% and 7.4% respectively. On the contrary, in the case of industrial sectors with high innovative activity, the probability of using patents is higher in those firms that have linked with universities and public research centers to innovate (6.7%). For these sector there is a significant negative incidence of obtaining process innovations (-6.8%), indicating as mentioned in the literature (Harabi 1995; Arundel 2001; Fernández Sánchez 2004) that this mechanism is less used to protect this type of innovations. There is a greater probability of use patents in the case of firms that obtained innovations of commercialization belonging to sectors that form the cluster 1 (5.9%) and cluster 3 (6.7%).

Table 11. Probit Models: PATENTS

	PATENTS		
	cluster 1 HIGH	**cluster 2 MEDIUM**	**cluster 3 LOW**
RDE			
INCTEC			
DISTEC			
PROF		+	+
LINKF			
LINKU	+		
PUBS			
RDDEP		+	+
PROD			
PROC	-		
ORG			
COM	+		+
SIZE	+		
AGE			
MNC			
GROUP		+	
X		+	

The structural factors are not significant to explain the patenting in the sectors of low innovative activity. On the contrary, it is observed a greater probability of use of patents in the case of larger firms that belong to sectors of high innovative activity (4.9%), and in those firms that be owned by an economic group of companies (9%) and are exporters (4.9%) in sectors of medium innovative activity.

Analyzing the determinants of secrecy, the results show that the probability of use this mechanism increases in cases in which firms are linked to universities and public S&T centers and to protect product innovations, since a positive incidence of these factors is observed in all clusters. In contrast to the patents, the cluster of high innovative activity shows a greater probability of using secrecy in those firms with higher capacities (45.9%), which have an R&D department (12.2%), and invest in technology transfer, training and consulting (9.8%). The greatest use of secrecy to protect process innovations indicated by the literature (Levin et al. 1987; Harabi 1995; Arundel 2001; Fernández Sánchez 2004) is observed only for medium innovative activity cluster (17.2%), while in the low innovative activity cluster are important the organizational innovations (5.2%).

Structural factors do not affect the probability of using secrecy, as they are not significant for any clusters, with the only exception of the medium innovative activity sectors for which being an exporting firm increase the probability of using secrecy by 9.5 %. This would indicate that the use of secrecy is extensive among Argentine firms belonging to all industrial sectors and regardless of their size, age and ownership of capital. On the contrary, the characteristics of the innovation process explain the intersectoral differences in the use of secrecy as mechanism of appropriation.

Table 12. Probit Models: SECRECY

	SECRECY		
	cluster 1 HIGH	**cluster 2 MEDIUM**	**cluster 3 LOW**
RDE			+
INCTEC			
DISTEC	+		
PROF	+		
LINKF			
LINKU	+	+	+
PUBS			
RDDEP	+		+
PROD	+	+	+
PROC		+	
ORG			+
COM			
SIZE			
AGE			
MNC			
GROUP			
X		+	

Considering the complementary assets, it is observed that its use is more probable in those firms that combine the obtaining of different types of innovations, mainly of product (with an incidence of between 15.8% and 26.6% depending on the cluster) and commercialization (between 12.3% and 8.8%); but also in the case of cluster 1, process (8.8%) and organizational (6.1%), and in the cluster 2 process (9.9%) innovations. This reflects the diverse nature of the instruments included in this category, which includes both productive and commercial factors from which firms designs their appropriation strategy. The efforts in innovation are only significant in the case of the low innovative activity cluster, showing that investment in knowledge generation raises the probability of using this mechanism by 5.6% and the investment in disembodied technology does so by 8.5%. On the contrary, for the

sectors of high and medium innovative activity, investment in innovation does not affect the use of this mechanism. Particularly for this last group, the links with public S&T centers and universities (7%) and to have a formal R&D department (10.9%) inside on the probability to use complementary assets, while a negative incidence is observed in the proportion of engineers and professionals in total employment (-66.42%, although significant only at 1%). This one highlights the result previously discussed when analyzing patenting, indicating that in sectors of medium innovative activity the greater capacities of firms affect the use of that legal mechanism. The structural factors do not appear to be a differentiating factor in the use of this mechanism among the different sectoral clusters, since only in the case of the cluster of high innovative activity it is observed a greater probability of using complementary assets in larger firms (3.1%), explaining the majority and generalized use of this mechanism by Argentine manufacturing firms.

Table 13. Probit Models: COMPLEMENTARY ASSETS

	COMPLEMENTARY ASSETS		
	cluster 1 HIGH	**cluster 2 MEDIUM**	**cluster 3 LOW**
RDE			+
INCTEC			
DISTEC			+
PROF		-	
LINKF			
LINKU		+	
PUBS			
RDDEP		+	
PROD	+	+	+
PROC	+	+	
ORG	+		
COM	+	+	+
SIZE	+		
AGE			
MNC			
GROUP			
X			

Finally, the analysis of the factors that affect the use of first mover mechanism also identify differentiating effects between clusters. For high innovative activity sectors, investment in R&D and engineering (15.8%) is relevant, preferably if it is carried out by a department or formal area of R&D (14.8%), and the investment in incorporated technology have a negative incidence (-14.7%). These results reinforce the importance of allocating the investment to the generation of knowledge to explain the use of first mover mechanism. On the contrary, for the low innovative activity cluster, the innovation efforts are not significant, and the combination of product (28.7%) and commercialization (8.5%) innovations has a positive impact on firms that have a formal R&D department (13.9%) and have linked with other firms to innovate (6.2%).

Table 14. Probit Models: FIRST MOVER

	FIRST MOVER		
	cluster 1 HIGH	**cluster 2 MEDIUM**	**cluster 3 LOW**
RDE	+		
INCTEC	-		
DISTEC			
PROF			
LINKF			+
LINKU			
PUBS			
RDDEP	+		+
PROD	+	+	+
PROC			
ORG		+	
COM			+
SIZE			
AGE	-		+
MNC			
GROUP			+
X		+	

Structural factors allow to differentiate among clusters too. The use of first mover is more likely among firms with greater age within the cluster of high innovative activity (significant marginal effect of -8% of the AGE variable); and it is higher among young firms (6.5%) and firms belonging to an economic group of companies (13.3%) within the sectors of low innovative activity. On the contrary, the cluster of medium innovative activity shows a greater probability of using first mover among exporter firms (9%), which complement their product innovations (13%) with organizational innovations (13.3%).

Summarizing the analysis of the sectoral specificity in the factors that explain the use of each particular mechanism (Table 11 to 14), the differentiated impact of the factors that characterize the innovative process and the structural characteristic of firms on the use of mechanisms according to the cluster (horizontal interpretation) is analyzed below.

The results of the analysis show that the type of innovative effort affects only the appropriation strategy of the high and low innovative activity cluster, indicating a difference between both extreme groups of firms. In the first group, investment in knowledge generation raises the probability of using the mechanism of first mover, while on the contrary in the case of low innovative activity cluster it mainly affects the use of secrecy and, to a lesser extent, complementary assets. The capabilities of the firms and having a formal R&D department also shows a difference in the appropriation strategy according to the cluster. For sectors of high innovative activity, these factors are significant to explain the use of secrecy, while for sectors of medium and low innovative activity these are the factors that explain the patenting. The links with public S&T centers and universities to innovate seem to rely on trust among the parties, since for the three sectoral clusters they explain the use of secrecy; although in the case of high innovative activity sectors, more intensive in knowledge, they also explain the

use of patents, while for medium innovative activity cluster they affect the use of complementary assets. The links with other firms, on the other hand, has shown to be relevant only in the case of sectors with low innovative activity and to explain the use of first mover. This result, added to the fact that belonging to an economic group of companies has also been significant for this cluster, reinforces the idea that in low innovative activity sectors the use of first mover occurs in cases in which the firms link with other companies (of the same economic group or not) to innovate. Innovation oriented public policies do not affect the appropriation strategy of Argentine manufacturing firms of any sectoral cluster.

A general result observed for all clusters is that product innovations are protected by strategic mechanisms of the three analyzed types. Process innovations show a negative effect to explain the use of patents in the case of high innovative activity cluster, indicating the preference of no patent this type of innovations, on the contrary, they do not affect the appropriation strategy of the low cluster innovative activity as are not significant for any mechanism. The innovation of commercialization alternatively explain the different mechanisms according to the considered cluster, although in any case they are significant to explain the use of secrecy. Meanwhile, the organizational innovations reinforce the effect of other types of innovations by raising the probability of using the complementary assets in the case of cluster 1, the first mover in cluster 2 and the secrecy in sectors of cluster 3.

Finally, the structural factors explain the appropriation strategy of high and medium innovative activity sectors and allow to differentiate the use of mechanisms between both groups. While for the industrial sectors of cluster 1 the size (to explain the use of patents and complementary assets) and the age (to explain first mover) are relevant; in the sectors of medium innovative activity, to be an exporter firm (to explain patents, secrecy and first

mover) and to belong to an economic group of companies (to explain patents) are relevant. On the contrary, there is no statistical significance of structural factors in low innovative activity sectors, with the only exception of first mover which use is more likely in the case of firms belonging to an economic group of companies and younger. The ownership of capital does not influence the appropriation strategy of Argentine manufacturing firms of any sectoral cluster.

These results, although limited to the case of the analyzed Argentine manufacturing firms, highlight the way in which the firms configure their appropriation strategy based on the characteristics of their innovation strategy and according to their industrial sector.

7. Conclusions

In an increasingly challenging competitive context for manufacturing firms, in which innovation and knowledge are determinants of the economic performance and market position of firms, it is relevant to study the strategies they develop to protect their innovations and appropriate their extraordinary rent associated. The firms configure their appropriation strategy based on the use of various mechanisms (legal and strategic) aimed at avoiding/delaying imitation or to maintain their market position. This research studies the determinants of such strategies at sectoral level, taking the case of the Argentine manufacturing firms (ENDEI 2010-2012) through a cluster analysis to group the industrial sectors (ISIC Rev.3 two digits) into those of high, medium and low innovative activity and the estimation of Probit models.

The analysis of the innovation strategy shows that on average the Argentine manufacturing firms analyzed have invested approximately 3.3% of their current income in innovation activities between 2010-2012. However, when considering the sectoral cluster firms belong

to, it is found that the so-called cluster of high innovative activity, which groups the most knowledge-intensive and, in general, greater productivity industrial sectors (chemical and medical instruments, oil production and various types of machinery and equipment) is characterized not only by a greater number of firms that carry out innovation activities of all types (76.6%), but also they distribute the funds more homogeneously by combining the acquisition of machinery with R&D investment. On the contrary, in the medium innovative activity cluster, which includes intensive capital industrial sectors (automotive and transport equipment, metal fabrications, non-metallic minerals and rubber and plastic products); and in the low innovative activity cluster, which includes the industrial sectors of mass consumption and intensive labor and natural resources (food and beverages, textiles, clothing, leather, wood, furniture, paper and publishing), the acquisition of machinery and equipment predominate. This results in a higher incidence of innovative firms in the case of cluster 1 (71.2% versus 54.4% observed in cluster 3), and although in all cases the obtaining of simultaneous product and process innovations predominates, the incidence of process innovations is greater in the cluster of medium and low innovative activity.

The appropriation strategy analysis shows that Argentine manufacturing firms belonging to the three sectoral clusters mostly use complementary assets to protect their innovations, and among them, active communication with customers and production scale are the instruments more utilized. The high innovative activity cluster is characterized by combining a greater number of mechanisms to configure its appropriation strategy; also showing a greater incidence in the use of secrecy, while it forms the cluster with the greatest presence within the total firms that patent. On the contrary, the cluster of low innovative activity is majority when considering the set of firms that use first mover and complementary assets; and within the

latter, the comparison among clusters highlights the greater relative use of production scale and distribution networks.

The econometric analysis of the determinants of the appropriation strategy of firms shows that it must be analyzed in the general framework of its innovation strategy, since the characteristics of such process affect the use of mechanisms that firms use to protect their innovations from potential competitors and to appropriate the rent associated with them. In this context, there are differences in the innovation and appropriation strategy according to the sectoral cluster considered, in some cases more marked than in others, but which allow to identify certain regularities in the appropriation strategy at sectoral level.

For the industrial sectors of high innovative activity, the allocation of the innovation investment is relevant to differentiate the appropriation mechanism used, finding that the investment in R&D affects first mover (mainly in firms with greater age) while the investment in disembodied technology explains a greater use of secrecy. In these sectors, the characteristics of the innovation process (capabilities, links with public S&T centers, formal R&D department) mainly explain the use of secrecy, while on the contrary, the type of innovative result affects the use of complementary assets. The patenting, which is observed with greater intensity in this sectoral cluster, is more likely in firms that link with public S&T centers and larger.

In the industrial sectors of medium innovative activity, it is found that innovation efforts do not explain the appropriation strategy. The patenting is more likely in firms with higher capabilities and who have a formal R&D department. The links with public S&T centers and universities increases the probability of using secrecy and complementary assets, while the type of innovative result that complements product innovations allows to distinguish between

first mover (organizational) and complementary assets (commercialization), being process innovations also relevant for this last mechanism. In these sectors, unlike what is observed for the other sectoral clusters, the exporting condition of the firms becomes relevant for the appropriation strategy.

Finally, in the industrial sectors of low innovative activity, the appropriation strategy is mainly explained by the characteristics of the innovation process, since the structural factors (age and the belonging to an economic group of companies) only affect first mover. In this group of sectors, the use of secrecy is more likely in firms that invest in R&D, have a formal department to carry out such activities, are link with universities and public S&T centers and complement product innovations with organizational ones. On the contrary, the probability of using complementary assets is greater when combining investment in R&D with the acquisition of disembodied technology, and complementing product innovations with commercialization ones. The patenting in this sectoral cluster is more likely in firms with higher capabilities and who carry out formal R&D activities. The links with firms, which are only significant for the industrial sectors that form this cluster, only affect the use of first mover.

Based on these results, the importance of the characteristics assumed by the innovation process and the consideration of the sectoral dimension for the study of the appropriation strategy of firms emerges as a general conclusion, since it is configured as an emerging of the innovation process. The evidence of the case of Argentine manufacturing firms shows that although in aggregate terms firms declare similar intensity in innovation expenditure, when considering the sectorial cluster to which they belong differences are observed regarding the allocation of the investment, the proportion of innovative firms and the type of innovation

obtained. In the same way, although complementary assets are the mechanism most used by Argentine firms, the consideration of the sectoral cluster allows differentiating the way in which firms combine the use of different mechanisms based on different innovation strategies. In this sense, although limited to the case of the Argentine manufacturing firms, these results provide evidence that challenges the widespread view in the literature about the role of appropriation as an incentive to innovation, and they emphasize that the way in which firms configure their strategy of innovation referred to efforts, capacities, the use of external sources of knowledge and cooperation with diverse agents, the way in which they carry out innovation activities and the type of results obtained, could be relevant to explain the conformation of their appropriation strategy.

An additional challenge and future line of research is the study of the effectiveness of the appropriation strategy to protect innovations, in order to evaluate the impact that different appropriation strategies have in the medium and long term on the economic performance of firms (e.g., future R&D projects, manufacturing competitiveness and productivity, positioning in the global context).

References

Arrow, Kenneth. 1962. "Economic Welfare and the Allocation of Resources for Invention." In *The Rate and Direction of Inventive Activity*, edited by R. Nelson. Princeton: Princeton University Press.

Arundel, Anthony. 2001. "The relative effectiveness of patents and secrecy for appropriation." *Research Policy* 30:611-624.

Arundel, Anthony, and Isabelle Kabla. 1998. "What percentage of innovations are patented? Empirical estimates for European firms." *Research Policy* 27 (2): 127-141.

Byma, Justin, and Aija Leiponen. 2007. "Can't Block, Must Run: Small Firms and Appropriability." Working Paper Series 1-07, The Mario Einaudi Center for International Studies, January.

Blind, Knut, Jakob Edler, Rainer Frietsch, and Ulrich Schmoch. 2006. "Motives to patent: Empirical evidence from Germany." *Research Policy* 35 (5): 655-672.

Brouwer, Erik, and Alfred Kleinknecht. 1999. "Innovative output, and a firm's propensity to patent: An exploration of CIS micro data." *Research Policy* 28 (6): 615-624.

CEP – Centro de Estudios para la Producción. 2006. "Lógica sectorial del uso del sistema de patentes en Argentina." *Síntesis de la Economía Real* 51:79-108.

Chabchoub, Norhène, and Jorge Niosi. 2005. "Explaining the propensity to patent computer software." *Technovation* 25 (9): 971-978.

Cincera, Michele. 2005. "The link between firms' R&D by type of activity and source of funding and the decision to patent." *DULBEA Research Series*, Working Paper, 05-10.

Cohen, Wesley M., Richard R. Nelson, and John P. Walsh. 2000. "Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)." *NBER Working Paper Series*, Working Paper 7552.

Combe, Emmanuel, and Etienne Pfister. 2000. "Patents Against Imitators: An Empirical Investigation on French Data." Cahiers de la MSE.

Dosi, Giovanni. 1982. "Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change." *Research Policy* 11 (3): 147-62.

Dosi, Giovanni, Luigi Marengo, and Corrado Pasquali. 2006. "How much should society fuel the greed of innovators? On the relations between appropriability, opportunities and rates of innovation." *Research Policy* 35:1110-1121.

Dosi, Giovanni, Christopher Freeman, and Silvia Fabiani. 1994. "The Process of Economic Development: Introducing Some Stylized Facts and Theories on Technologies, Firms and Institutions." *Industrial and Corporate Change* 3 (1): 1-45.

Fernández Sánchez, Esteban. 2004. "Formas de apropiación de las ganancias de una innovación." Universia Business Review 1 (1).

Freeman, Christopher. 1994. "The economics of technical change." *Cambridge Journal of Economics* 18 (5): 463.

Galende del Canto, Jesús. 2006. "La apropiación de los resultados de la actividad innovadora." Universidad de Salamanca, mimeo.

Geroski, Paul. 1995. "Markets for Technology: Knowledge, Innovation and Appropriability." In *Handbook of the Economics of Innovation and Technological Change*, edited by P. Stoneman. Cambridge, Oxford: Blackwell.

González-Álvarez, Nuria, and Mariano Nieto-Antolín. 2007. "Appropriability of innovation results: An empirical study in Spanish manufacturing firms." *Technovation* 27:280-295.

Greene, William H. 2003. *Econometric analysis*. Pearson Education India.

Griliches, Zvi. 1990. "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature* 28 (4): 1661-1707.

Hanel, Petr. 2006. "Intellectual property rights business management practices: A survey of the literature." *Technovation* 26 (8): 895-931.

Harabi, Najib. 1995. "Appropriability of technical innovations: An empirical analysis." *Research Policy* 24 (6): 981-992.

Holgersson, Marcus. 2013. "Patent management in entrepreneurial SMEs: a literature review and an empirical study of innovation appropriation, patent propensity, and motives." *R&D Management* 43 (1).

Hu, Albert G., and Gary H. Jefferson. 2009. "A great wall of patents: What is behind China's recent patent explosion?" *Journal of Development Economics* 90 (1): 57-68.

Hurmelinna-Laukkanen, Pia, and Kaisu Puumalainen. 2007. "Nature and Dynamics of Appropriability: Strategies for Appropriating Returns on Innovation." *R&D Management* 37 (2): 95-112.

Hurmelinna-Laukkanen, Pia, Mika Vanhala, and Heidi Olander. 2016. "Appropriability profiles – different actors, different outcomes." *International Journal of Innovation Management* 20 (08).

Johnson, Bjørn H., and Bengt Å. Lundvall. 1994., "Sistemas nacionales de innovación y aprendizaje institucional." *Comercio Exterior* 44 (8): 695-704.

Klevorick, Alvin K., Richard C. Levin, Richard R. Nelson, and Sidney G. Winter. 1995. "On the sources and significance of interindustry differences in technological opportunities." *Research Policy* 24 (2): 185-205.

Laursen, Keld, and Ammon Salter. 2005. "The Role of Legal Appropriability Strategy in Shaping Innovative Performance." *DRUID*, Department of Industrial Economics and Strategy, Working Paper no. 05-02.

Leiponen, Aija, and Justin Byma. 2009. "If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies." *Research Policy* 38 (9): 1478-1488.

Levin, Richard C., Alvin K. Klevorick, Richard R. Nelson, Sidney G. Winter, Richard Gilbert, and Zvi Griliches. 1987. "Appropriating the Returns from Industrial Research and Development." *Brookings Papers on Economic Activity* 3:783-831.

Lieberman, Marvin B., and David B. Montgomery. 1988. "First-mover advantages." *Strategic Management Journal* 9 (S1): 41-58.

López, Andrés. 2009. "Innovation and appropriability: empirical evidence and research agenda." In *The Economics of Intellectual Property. Suggestions for Further Research in Developing Countries and Countries with Economies in Transition*, edited by World Intellectual Property Organization, January 2009.

López, Andrés, and Eugenia Orlicki. 2007. "Innovación y mecanismos de apropiabilidad en el sector privado en América latina." In proyecto OMPI-CEPAL *Sistemas de Propiedad Intelectual y Gestión Tecnológica en Economías Abiertas: una Visión Estratégica para América Latina y el Caribe*. CENIT, 30 de agosto de 2007.

Malerba, Franco, and Luigi Orsenigo. 1997. "Technological regimes and sectoral patterns of innovative activities." *Industrial and Corporate Change* 6 (1): 83-117.

Mansfield, Edwin. 1986. "Patents and Innovation: An Empirical Study." *Management Science* 32 (2): 173-181.

Milesi, Darío, Natalia Petelski, and Vladimiro Verre. 2017. "Innovación y uso de patentes en la industria manufacturera argentina." In *La Encuesta Nacional de Dinámica de Empleo (ENDEI) como herramienta de análisis. La innovación y el empleo en la industria manufacturera argentina*, edited by CEPAL, N., A. M. de Ciencia, et al. (2017), 231-254. LC/TS.2017/102.

Milesi, Darío, Vladimiro Verre, and Natalia Petelski. 2017. "Science-industry R & D cooperation effects on firm's appropriation strategy: the case of Argentine biopharma." *European Journal of Innovation Management* 20 (3): 372-391.

Milesi, Darío, Natalia Petelski, and Vladimiro Verre. 2014. "Apropiación privada de los resultados de innovación." In *Tópicos de la teoría evolucionista neoshumpeteriana de la innovación y el cambio tecnológico,* edited by Yoguel, G. Robert, V., and Barletta, F., 357-376. Universidad Nacional de General Sarmiento, Los Polvorines, Argentina.

Milesi, Darío, Natalia Petelski, and Vladimiro Verre. 2013. "Innovation and choice of appropriation mechanisms: evidence from Argentine microdata." *Technovation* 33 (2-3): 78-87.

Neuhäusler, Peter. 2012. "The use of patents and informal appropriation mechanisms—Differences between sectors and among companies." *Technovation* 32 (12): 681-693.

Paula, Fábio de Oliveira, and Jorge F. Da Silva. 2019. "The role of the appropriability mechanisms for the innovative success of Portuguese small and medium enterprises." *International Journal of Innovation Management* 23 (04): 1-23.

Pavitt, Keith. 1984. "Sectoral patterns of technical change: towards a taxonomy and a theory." *Research Policy* 13 (6): 343-374.

Sattler, Henrik. 2003. "Appropriability of Product Innovations: An Empirical Analysis for Germany." *Research Papers on Marketing and Retailing* 003, University of Hamburg.

Teece, David J. 1986. "Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy." *Research Policy* 15 (6): 285-305.

Veugelers, Reinhilde, and Bruno Cassiman. 1999. "Make and buy in innovation strategies: evidence from Belgian manufacturing firms." *Research Policy* 28 (1): 63-80.

Winter, Sidney G. 1984. "Schumpeterian competition in alternative technological regimes." *Journal of Economic Behavior & Organization* 5 (3-4): 287-320.