Knowledge sources complementarities in Argentina´s production networks

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Knowledge Sources Complementarities in Argentina's Production Networks

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Abstract

The access to different knowledge sources is a key aspect for innovative firms and the characteristics of production networks in which firms are involved may condition the relative importance of those sources. Although internationalization is a natural process for the development of production networks also in emerging economies, in this paper we show that the connections within the network and inside the domestic system are not negligible for improving firms' innovation results. The empirical analysis of cross-sectional firm level data of two Argentinean production networks comprises both indirect and direct complementarity tests, these based on data from a specific survey on the automotive and iron-steel networks. The results provide evidence for significant complementarities between internal and external sources of knowledge while the relevance of foreign sources is not absolutely confirmed, aspects that lead to implications for the capabilities building process of developing contexts.

Keywords:

Complementarity; Innovation; Knowledge sources; Technology Acquisition; Production networks

JEL Codes: B52; L62; L61

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1. Introduction

Present understanding of innovation requires the assumption that firms do not innovate in isolation but there are external influences by mean of complementary information and knowledge that may become key drivers of firms' performance. The search for new ideas outside the firms' boundaries may involve a wide range of external links and actors to carry out innovation objectives. Therefore, the new models of innovation explain the predominance of open firms' strategies that leads to the study of complementarity, underlining the fact that this is a context-specific aspect (Chesbrough, 2003, Arora *et al.*, 2004, Mohnen and Röller, 2005, Cassiman and Veugelers, 2006, Laursen and Salter, 2006).

Some recent empirical analysis perform the test of the impact of complementarity on the firm productivity and innovation results, and most of the available evidence shows the existence of a significant complementary relationship between internal R&D and R&D cooperation that leads to support the relevance of the absorption capacity. Results are consistent with the existence of complementary internal and external innovation activities in manufacturing Belgium firms (Cassiman and Veugelers, 2006) and there is also evidence of significant complementarities between internal R&D and R&D cooperation, not being so clear between internal and contracted R&D for the German case (Schmiedeberg, 2008). Meanwhile, in a recent analysis of Spanish innovative firms, the complementarity appears only between internal innovation and either external or cooperative innovation but not with both together (Serrano-Bedia *et al.*, 2012). Nonetheless, the effects on firm performance depend on firm size and the specific strategic combinations because the presence of the high costs associated to the complexity of managing multiple partnerships (Belderbos *et al.*, 2006).

In this paper, we will follow the empirical rigorous method presented by Cassiman and Veugelers (2006) to test the existence of complementarity in the innovation strategies of Argentinean firms. The contribution of this paper is twofold: On the one hand, our empirical analysis provides new evidence of complementarity between different sources of knowledge for the innovation performance of manufacturing firms under the optics of the production networks –particularly, the automotive and iron-steel networks in Argentina are studied; this is relevant because most of the empirical evidence has been mostly generated for developed countries and much less for the case of developing economies. On the other hand, this contribution introduces the difference between national and foreign sources, revealing the crucial importance of both internal knowledge and the domestic context in the firms' innovation results.

The empirical analysis is based on the Production Network (PN) approach as a suitable framework to analyze complementarity. A PN is defined as an economic space of technological capabilities and skills building that is formed first, by one or more organizing firms (the PN cores) and all their suppliers and customers; secondly, it is also defined by the interrelationships that derive from purchases and sales, information flows, commercial and productive knowledge flows, through both formal and informal channels (Albornoz and Yoguel, 2004, Albornoz *et al.*, 2005, Novick and Carillo, 2006). Therefore, a PN involves flows of goods and services in a stable long run relationship; it is established as a contextual framework and as an epistemic community where firms operate, leading them to generate and externalize codified and tacit knowledge through interaction and facilitating the exchange and collective knowledge accumulation (Poma, 2000, Novick and Carillo, 2006). Thus, the generation, circulation and appropriation of knowledge and synergies are key components of the firms learning process that depends on the following two key items: a) The endogenous competences that derive from the internal interactive learning (accumulated knowledge that allows future absorption and also affects the utility of the acquired knowledge); and b) The knowledge flow with other actors through interaction, including both linkages within the PN (between the core and the suppliers and customers, and among the firms in the PN), as well as linkages outside the PN that can be formal or informal, taking place inside the domestic system or with foreign agents (between firms in the PN and other firms outside it, between firms and research and technical institutions, between firms and universities, etc) (Albornoz*, et al.*, 2005).

The paper is structured as follows: In section two, we present the theoretical background that frames the hypotheses development. In section three, we present the methodology and the description of the data, the construction of the indicators and the statistical methods used. Section four discusses the main results of the quantitative analysis, and section five presents some main concluding remarks.

2. Theoretical framework and hypothesis development

An important aspect of firms' innovation strategies is the search of new information and knowledge outside the firm boundaries. This justifies why the relationships that firms establish with other agents is a topic that has gained interest in the innovation literature. Some of the objectives in the economic research have been to search the reasons why innovative firms need to accede to knowledge sources, to cooperate with external actors and its impact in the firms' performance. And one particular question is to analyze rigorously whether there is a complementarity relationship between external sources and internal R&D and to what extent this affects firms' performance and innovative results.

The traditional conception of innovation, based on internal, specialized and closed R&D, has been losing effectiveness due to the requirements of the rapid technological change, the innovation-based competition, and the reduction of the innovations life cycle. These aspects enlarge the necessity of firms to expand their access to new knowledge, to more qualified human resources and specialized suppliers, leading to intermediary forms between market-based transactions and internal organization that avoid the costs associated with internalizing new tasks (Pisano, 1990, Miotti and Sachwald, 2003). On the tradition of transaction cost theory (Coase, 1937, Arrow, 1962, Williamson, 1985) and property right theory (Grossman and Hart, 1986), the main prediction is the existence of substitutability between the internal development of innovative activities and the external acquisition of knowledge[1]. Although, it is plausible to think that these knowledge sources may be complementary for a successful innovative performance when internal competences are necessary and crucial to effectively absorb external knowledge. This means that internal R&D contributes to develop the firm's ability to *"(…) identify, assimilate, and exploit knowledge from the environment"* (Cohen and Levinthal, 1989), what is known as absorptive capacity of the firm. From a management perspective, as Teece (1986) points out, the complementary assets may be crucial for the successful commercialization of an innovation. The key argument is that firms need to expand their access to external sources, and collaboration with external agents is seen as a way to achieve a better competitive position, as a source of higher efficiency lead by a better exploitation of economies of scale and dynamic capabilities, making innovation activities more flexible and dynamic (Teece, 1986, Teece *et al.*, 1997). In addition, internal knowledge creation activities usually reduces the inefficiencies of external acquisition and permits the modification and improvement of the knowledge absorption from outside the firm; in such a case, complementarity relations between internal and external knowledge sources for innovation arise. Thus, this is a controversial topic because opposed arguments can be

[1] External acquisition could have large *ex-ante* transactional costs regarding searching and bargaining, while large *ex post* costs are regarding the execution and enforcement of contracts; a substitutability effect between internal and external innovative activities seems to prevail.

found in the literature that allow us to expect both substitutability and complementarity relations.

The related literature identifies different types of actors depending on whether there is horizontal collaboration i.e. that carried out with competitors; or vertical collaboration, with customers and suppliers; as well as institutional collaboration, which includes universities and research centers (Belderbos *et al.*, 2004a). The motivations are conditioned by the kind of agent with whom they collaborate, i.e. collaboration with competitors can allow firms to exploit economies of scale and scope and to reduce risks while an active involvement of customers may induce a positive impact on innovation success because the reduction of risks associated with the introduction of new products on the market and the expansion of sales (Belderbos *et al.*, 2004b, Von Hippel, 2007). Meanwhile, institutional collaboration has traditionally been linked to public support –but not exclusively- and a vast empirical evidence introduce the role of public institutions and public funding in the analysis of the decision to collaborate (Abramovsky *et al.*, 2005, Mohnen and Röller, 2005).

Under the lens of an open innovation model, the study of the firms' ability to adopt external flows of knowledge in combination with internal R&D and the links with other actors gain sense (Chesbrough, 2003, Laursen and Salter, 2006). A possible form of research partnership is then defined by the share of R&D activities among different units despite these are economically independent, although this would also involve a significant internal effort in R&D (Hagedoorn *et al.*, 2000, Hagedoorn, 2002). Those firms that taking external flows of knowledge as a main input in the innovation process have higher absorptive capacities, will also have a greater propensity to collaborate (Cassiman and Veugelers, 2002, Lopéz, 2008).

This diversity of sources allows us to make a first distinction taking into account the geography of the knowledge sources as well as the scope of them. In particular, we could detect complementarity between national and foreign sources and, on the other hand, in the relationship between internal (firm-specific) and external sources. The development of hypothesis in this paper is then supported in the following two pairs of sources: National and Foreign sources; and Internal and External sources as the discussion about them follows.

2.1 National and foreign knowledge sources of innovation

The increasing internationalization affecting diverse economic relationships and transactions in last decades is a consequence of the expansion of international trade, capital, technology and information flows, having been greater the interconnection between the socio-institutional and production systems of nations. This process has also effects the innovation field since in a more and more globalised economy the innovation process is also involving foreign sources of knowledge in addition to the domestic ones.

A recurrent issue in the literature is precisely the way in which the national dimension of the systems of innovation -or what is conceptualized as the National Systems of Innovation (NSI)- is affected by the internationalization phenomenon. There are diverse arguments in the literature to justify the relevance that foreign knowledge sources may acquire into the innovation performance of firms. Some studies generally focus on the *internationalization and interdependence degree of the NSI* (Niosi and Bellon, 1994, Bartholomew, 1997, Fransman, 1999). Another line of research is more directly dealing with the *internationalization degree of R&D activities and the impact of foreign firms in the innovation level of host locations* (Pavitt and Patel, 1999, Cantwell and Piscitello, 2000, Bas and Sierra, 2002, Alvarez and Molero, 2005). And others study the *institutional and geographical barriers to internationalization* (Mowery and Oxley, 1997, Mytelka, 2000). The growing internationalization of NSI is a key aspect commonly agreed in the related literature and it is also pointed out that national institutions still keep their relevance as supportive of the innovative activity even in activities increasingly internationalized (Carlsson, 2006).

In this context, the analysis of knowledge sources of innovation implies not only understanding the relevance of international flows of knowledge, the impact of foreign firms in host location and how firms learn abroad, but also to inquire into the relevance of the domestic sources for the innovative performance of firms operating in internationalized activities (Johnson, 1992, Lundvall, 1992, Chudnovsky, 1999, Balzat and Hanusch, 2004, Lundvall, 2007). A large part of the literature focuses mainly on developed countries while evidence built on the analysis of developing countries is still scarce. This lack is precisely addressed in this paper where we analyze the complementarity of knowledge sources under the scope of internationalized production networks. Then, a general concern of this article is to know to what extent the firms' innovative results are affected by the internationalization trends in an emerging economy such as Argentina. The question is referred to the effects of the *internationalization* phenomenon on the NSI and in particular, whether it reduces the relative importance of domestic sources for innovation in favor of foreign sources of knowledge, prevailing a substitution effect or on the contrary there is a complementarity relationship between the two that is associated with a better innovative performance of firms.

Thus, our first working hypothesis is that *there is complementatity between domestic and foreign sources of knowledge and this enhances firms' innovation results (H1).*

2.2. Internal and external Knowledge sources of innovation

Successful innovation depends on the development and integration of new knowledge into the creative process of the firm, and this can take place in many cases through the combination of both internal and external sources of knowledge (Cassiman and Veugelers, 2002). Industrial and innovation literature has studied the degree in which internal and external knowledge sources are complementary or substitutes for innovation. Besides, it is largely agreed that the presence of internal capabilities defined by the notion of absorptive capacity becomes a key condition for the successful integration of external knowledge (Cohen and Levinthal, 1990) and the possibilities to get higher benefits from their incorporation into the innovation strategy, this leading to a higher tendency to cooperate (Abramovsky*, et al.*, 2005). Moreover, the potential presence of incoming spillovers may be reinforced by the ability to internalize external knowledge and this finally will affect the firm performance and the innovation results (Cassiman and Veugelers, 2002).

The most common econometric strategy to deal quantitatively with the issue of complementarity has been the correlation approach in which simple correlations between the variables, with or without controls, are analyzed (Mohnen and Röller, 2005)[2]. Some studies found that internal and external innovative activities tend to be substitutes; evidence is provided for the US (Blonigen and Taylor, 2000), and similar results are found for some emerging economies such as the Indian case (Basant and Fikkert, 1996). Alternatively, others found complementarity relations between knowledge sources, being diverse the focus of their analysis: some findings correspond to developed countries such as the US, Japan and some European countries (Arora and Gambardella, 1990, Cassiman and Veugelers, 2002), and others found

[2] There is another strategy, the *reduced form approach,* although it has identification problems and the antecedents in this line are minor (Deolalikar and Evenson, 1989).

complementarity as well between internal and external sources in some emerging economies such as Brazil and India (Deolalikar and Evenson, 1989, Braga and Willmore, 1991)[3]. Thus, the empirical literature in this line does not reach conclusive results and it rather test directly the complementarity of sources in relation to innovation results.

Another empirical strategy adopts a direct approach and tries to cover this gap, some empirical studies being concerned with the study of complementarities in relation to the performance effects. In particular, Mohnen and Röller (2005) evaluate the complementarity between obstacles to innovation in European firms, and Miravete and Pernias (2006) apply this approach to analyze to complementarities between product and process innovations in Spanish firms. Nonetheless, the empirical antecedents that use discrete data are relatively scarce. As previously said, one of the most influential paper in this line is the work of Cassiman and Veugelers (2006) applying this method to analyze complementarity between external knowledge buy and internal R&D activities in Belgium firms. Their results point out that these activities are complementary to innovation, and this is sensitive to contextual aspects.

In sum, the available empirical literature has not reached conclusive results and the evidence that applies the more modern techniques is scarce. This is especially true for emerging economies, where a notable gap in the literature can be detected. In that sense, a second objective of this paper is to evaluate the existence of complementarity between internal and external sources of knowledge in relation to innovation results. With this objective in mind, firms from both the automotive and the iron and steel networks in Argentina are studied.

Therefore, our second working hypothesis is that *there is a complementary relationship between internal and external sources of knowledge that positively impact firms' innovation results (H2).*

3. **Methodology and Data Source**

The test of complementarities in presence of discrete data for the independent variables implies testing if the objective function is supermodular in these arguments[4].

[3] In particular, Audretsch *et al.* (1996) find out in the case of Germany that internal and external activities are substitutes in the *low tech* sectors, while there is complementarity in *high tech* sectors.

[4] When continuous data for the independent variables are available, an alternative way would be the "direct objective function approach" that leads to regress the innovation variable with a cross variable of the dependent variables that we want to test for complementarity, besides the controls. Examples of this exercise in innovation economics are found in Lokshin *et al.* (2008) and Hou and Mohnen (2011).

Supermodular functions belong to a mathematical field known as *Lattice Theory*[5]. A real function $I(x)$ defined in the lattice X is supermodular in x if $I(x')+I(x'')\leq I(x'\vee x'')+I(x'\wedge x'')$ is satisfied by all x' and x'' in X. When the inequality is inverse, $I(x)$ is submodular. The condition of supermodularity between two arguments implies that the function shows complementarity between them and the condition of submodularity shows substitutability (Milgrom and Roberts, 1990, Topkis, 1998).

This specification of the function allows, besides complementarities, the existence of indivisibilities, increasing scale returns, synergy and systemic effects, as long as the function cannot be convex, concave, differentiable nor even discontinuous in some points (Milgrom and Roberts, 1990, 1995). In that sense, to specify that an innovation function is supermodular or submodular in some arguments imposes relatively scarce restrictions concerning the nature of the innovation process itself.

It can be assumed, for instance, that the innovation function depends on the recurrence to knowledge sources in addition to traditional structural factors. We present in the following section 3.1, the specification of the innovation function and the econometric issues related to the complementarity tests. Next, Section 3.2 contains the description of data sources and the main characteristics of the sample.

3.1. Econometric Issues and Complementarity Tests

To estimate the coefficients of the sources of knowledge for innovation to test the complementarity inequalities, an innovation function for each firm *i* is specified [1], where I^* represents an index underlying the ordinal responses observed (*i.e. it is an unobserved latent variable*).

$$I^{*i}(A_1^i, A_2^i, X^i, \gamma, \beta) = (1-A_1^i)(1-A_2^i)\gamma_{00} + A_1^i(1-A_2^i)\gamma_{10} + A_2^i(1-A_1^i)\gamma_{01} + A_1^iA_2^i\gamma_{11} + \beta X^i + \varepsilon^i$$
[1]

There, A_1^i and A_2^i are dummy variables that represents the recurrence to knowledge sources to innovation (for instance, foreign and national sources, or internal and external sources), γ their coefficients (necessary to carry out the complementarity tests), and X^i a set of control variables (Size, Property of Capital, Industry, Exports).

[5] A Lattice is a partially ordered set, where there is a binary relation that is reflexive, anti-symmetric and transitive; and where for each pair of elements there is a supremum by pairs ($x'\vee x''$, the join) and a infimum ($x'\wedge x''$, the meet), that are contained inside the set (Milgrom and Roberts, 1995, Topkis, 1998).

Testing the complementarity between knowledge sources A_1 and A_2, implies to contrast the following inequality:

$$\gamma_{11} - \gamma_{10} \geq \gamma_{01} - \gamma_{00} \qquad [2]$$

If [2] holds, the innovation function is supermodular in A_1 and A_2, and these knowledge sources are complementaries. Moreover, the innovation function could be submodular, meaning that the obstacles are substitutes. The inequation to be tested would be analogous to [2], but the inequality would be presented in opposite signs.

The possibility to carry forward hypothesis tests around super- and submodularity will be feasible if the estimates are consistently counted in γ. Obtained these estimates, it will be possible to establish the adequate hypothesis, as follows. The hypothesis that the innovation function is supermodular in knowledge sources A_1 and A_2 is:

$H_0: ks \leq 0$

$H_1: ks > 0$

Where $s = \gamma_{00} + \gamma_{11} - \gamma_{10} - \gamma_{01}$. However, it must be pointed out that rejecting H_0 does not imply that the two sources in question are substitutes or supplementary. To test this issue, we have to see if the innovation function is submodular in sources A_1 and A_2, and the hypothesis is analogous in this way:

$H_0: ks \geq 0$

$H_1: ks < 0$

In order to contrast these hypotheses, the so called *Wald Test* for inequality restrictions is applied:

$$(S\tilde{\gamma} - S\hat{\gamma})'[Scov(\hat{\gamma})S']^{-1}(S\tilde{\gamma} - S\hat{\gamma}) \qquad [3]$$

Where $\hat{\gamma}$ is a consistent estimator of γ, S represents a matrix that summarizes the imposed restrictions for the defined inequalities, and $\tilde{\gamma}$ is the vector that minimizes the expression [3] below H_0. Kodde and Palm (1986) have tabulated the inferior and superior critical limits of this Wald statistic for different significance levels commonly used. Values of the Wald statistic that are inferior to the lower bound critical value will imply the acceptation of the defined null hypothesis; while if the statistic is superior to the upper bound critical value, the null hypothesis should be rejected. When the value of the statistic is found between the two bound critical values, the test will be inconclusive. Lastly, the situation can present itself the acceptance of the null hypothesis of supermodularity, and also of submodularity; the reason being that the inequalities of H_0 are not strict, and in this case one can say that neither supermodularity nor submodularity exist in a strict manner. In that case, and additional Wald test could be made, with null hypothesis equal to zero.

Since we work with an ordinal variable of innovation, we define two ordered probit models to estimate, on the one hand, the coefficients of recurrence to national and foreign linkages (Model I), and on the other, the coefficients of recurrence to internal and external knowledge sources (Model II).

Thus, Model I is defined as:

$$I^{*i}\left(KS_n^i, KS_f^i, Y^i, \lambda, \upsilon\right) = \left(1 - KS_n^i\right)\left(1 - KS_f^i\right)\lambda_{00} + KS_n^i\left(1 - KS_f^i\right)\lambda_{10} + KS_f^i\left(1 - KS_n^i\right)\lambda_{10} + KS_n^i\, KS_f^i \lambda_{11} + \chi Y^i + \upsilon^i \quad [4]$$

Where I^* represents an unobserved index underlying the ordinal responses observed (*i.e.* it is a latent variable), while KS_n^i is the recurrence of firm *i* to national linkages, KS_f^i is the recurrence of firm *i* to foreign linkages, both binary variables, λ their coefficients (analogous to γ), and Y^i a set of control variables (Size, Property of Capital, Industry, Exports, External Buy of Technology, Internal Leaning).In turn, the ordered probit model corresponding to de innovation function of Model II is:

$$I^{*i}\left(KS_{int}^i, KS_{ext}^i, Z^i, \delta, \mu\right) = \left(1 - KS_{int}^i\right)\left(1 - KS_{ext}^i\right)\delta_{00} + KS_{int}^i\left(1 - KS_{ext}^i\right)\delta_{10} + KS_{ext}^i\left(1 - KS_{int}^i\right)\delta_{10} + KS_{int}^i\, KS_{ext}^i \delta_{11} + \mu Z^i + \omega^i \quad [5]$$

Where I^* is, again, a latent variable, while KS_{int}^i is the recurrence of firm *i* to internal knowledge sources, KS_{ext}^i is the recurrence of firm *i* to external knowledge sources, both binary variables), δ their coefficients (analogous to γ), and Z^i a set of control variables (Size, Property of Capital, Industry, Exports).

In the two models we consider I^* as a latent variable underlying the ordinal variable of innovation used; in both of them, innovation takes three possible labels. Then, instead of observing I^* we observe:

$I = 1$ if $I^* \leq \tau_1$

$I = 2$ if $\tau_1 \leq I^* \leq \tau_2$

$I = 3$ if $\tau_2 \leq I^*$

The τ's are unknown "threshold" parameters that must be estimated along with other parameters. Estimation of these models is undertaken by maximum likelihood, which in the case of the ordered probit model requires to assuming that the error terms (ν^i and ω^i) are distributed as a standard normal. Through the estimation of the parameters, we perform the tests of the hypothesis considering the restrictions indicated above, replacing only γ_l's by λ_l and δ_l, according to the model.

3.2. Data Source and Indicators

The data source for this analysis has its origin in a technological survey specifically designed under a production network (PN) perspective that was carried out during 2006. A total of 163 valid respondents were obtained among which 89 were car parts producers, suppliers of automakers, and 74 firms were from the iron-steel PN (IPN); all of them were located in the provinces of Buenos Aires, Córdoba and Santa Fe, in Argentina[6]. The survey collect data for the period 2001-2005 and it contains some general questions about the structural aspects of firms (size, property of the capital, industry, exports, sales, employment, etc.); questions about the interchanges' structure inside the PN (distribution of sales, purchasing, material and parts suppliers, etc); a set of questions referred to the linkages and relationships among the actors involved in the PN (contractual relations, cooperation activities, technical linkages, etc.); issues related to the firms innovative activities (types of innovations introduced, results of the innovations, the importance of each type of innovation introduced, expenditure on innovative activities, personal distribution, quality activities, etc..); and

[6] The survey was carried out as a part of the Research Project "Production networks, innovation and employment", Vacancy Project 057/03 from the Science, Education and Technology Secretary from the Republic of Argentina.

finally, some questions about human resource management (organization of the work process, etc..) and about training activities.

Regarding the composition of the sample, almost 32% of firms have annual sales below $ 5 million and around 28% of firms more than $ 30 million. On the other hand, 26% of firms do not have exports and for 37% of firms more than 20% of their sales are exports. The representative of the auto-parts producer firms is high: they represent 54% of the sample that cover around 25% of the Argentinean population of direct suppliers of automakers. The other 46% of the sample corresponds to the IPN firms and as longs as a PN has both backward and forward linkages with the core, the sample includes suppliers as well as clients of the core. The suppliers represent almost 60% of the IPN sample and this includes the production of metallic inputs, chemical inputs, machinery and instruments, electrical input, specific services (such as equipment maintenance, machining or process supplies, etc.) and nonspecific (such as recycling, services for conveyor belts, etc.), and mining supplies. On the other hand, the users or customers represent 40%, and include service centers (cutting and bending of metal sheet, structural shapes, strips, etc.), producers of metal inputs and chemical inputs, machinery and equipment, as well as final users in various industries, such as construction and metalworking.

The dependent variable is an ordinal indicator of *Innovation* constructed integrating the types of innovation introduced by the firms, its importance and its results (it assumes values between 1 and 3). Precise details of the indicators and variables are presented in the Appendix. As it can be seen in Table 1, in more than 41% of firms the indicator of innovation shows a low value and around 30% of the sample has a high level of innovation.

Table 1. Innovation Levels in the sample

	All Sample		
	Low	**Medium**	**High**
Innovation Indicator	41,36%	28,40%	30,25%

To construct the binary variables of knowledge sources recurrence, four types of knowledge sources for innovation were taken account: *National Linkages*, *Foreign Linkages*, *Internal Learning* and *External Buy of Technology*. This selection comprises the major and typical determinants of innovation that were developed in previous works

(Morero, 2010, 2011, 2013), and they can be classified as national, foreign, internal or external knowledge sources –in Table 2.

Table 2. Sources of knowledge to innovation.

	External	Internal	National	Foreign
Internal Learning		X	X	
External Buy of Technology	X		X	X
National Linkages	X		X	
International Linkages	X			X

The first step of our analysis before performing the super and submodularity tests between national and foreign knowledge sources, is taking national and international linkages as proxies for these sources respectively. They allow us to construct four dummy variables of recurrence either to national and foreign sources. The binary variables point out if the firm recurs neither to national nor to international linkages (*Not National Not Foreign*), if the firm draws upon national linkages but it does not to international linkages (*Only National*), if the firm resorts to international linkages but does not to national (*Only Foreign*), and if the firm recurs jointly to the two different sources (*National & Foreign*). Table 3 shows the frequency of these indicators in the sample. These indicators are taken as independent variables of Model I. In addition, a series of control variables were included in the model; in particular, the firm *Size, the Origin of Capital*, *the Industry* (following Pavitt taxonomy[7]), the *Export Profile*, and other major determinants of innovation that were not compound the independent variables (*Internal Leaning* and *External Buy of Technology*).

Table 3. Recurrence to National and Foreign Linkages. Complete Sample.

	Frequency
Not National Not Foreign	11,73%
Only National	42,59%
Only Foreign	5,56%
National & Foreign	40,12%

[7] Details about this taxonomy can be found in the Appendix.

Secondly, for the test of super and submodularity between internal and external knowledge sources, four types of knowledge sources are considered *(National Linkages*, *Foreign Linkages*, *Internal Learning* and *External Buy of Technology*), and also in this case four dummy variables of recurrence to these sources were constructed. The binary variables reflect if the firm recurs neither to internal nor to external knowledge sources (*Not Internal Not External*), if it does to internal knowledge sources but does not to external ones (*Only Internal*), if the firm resorts to external knowledge sources but it does not to the internal (*Only External*), and if the firm recurs jointly to both of them (*Internal & External*). Table 4 shows the frequency of these indicators for the complete sample. These indicators constitute the independent variables of Model II. A series of control variables has also been included in the model; again *Size, Origin of Capital*, *Industry* and the *Export Profile*. Details about the construction of these variables are also found in the Appendix.

Table 4. Recurrence to Internal and External Knowledge Sources. Complete Sample.

	Frequency
Not Internal Not External	25,15%
Only Internal	12,27%
Only External	23,32%
Internal & External	39,26%

4. Discussion of results

In this section we discuss the results obtained from the quantitative analysis. Table 5 shows the maximum likelihood estimates of Model I and Model II. In both cases, a series of regressions were made with alternative dependent variables of innovation, and also different combinations of control variables were explored but the results presented here are the more robust[8]. The Wald tests to super and submodularity are robust to these variations and the acceptance and rejects tests show that it holds in each case –Table 6-. The Models I and II were selected by the minor Akaike Information Criterion (AIC), which comes to indicate a better fit.

The estimated coefficients of Model I are expressed as the deviations of the coefficient of *Not National and Not Foreign Linkages* to avoid collinearity problems with

[8] These estimation results can be obtained from authors upon request.

the others dummies for knowledge sources. Besides the recurrence to knowledge sources indicators to perform the supermodularity tests, it must be noted that Model I shows a proportion of correct prediction of 0.50 and there is a positive and significant relation between the *latent innovation* (I^*) and internal learning. This result would reveal that a high level of internal knowledge makes more likely to get a higher level of innovation. In addition, it is also positive and significant the relationship observed between innovation results and the firms external buy of technology. These findings come to indicate the relevance of absorptive capacities for innovative firms and also the role that the acquisition of knowledge embodied in technologies could have for firms in a developing context.

On the other hand, the overall prediction of Model II is also notable, 0.52 proportion rightly predicted and in this case the coefficients are expressed as deviations of the coefficient of *Not Internal and Not External* knowledge sources recurrence; again this is done to avoid collinearity problems with the others dummies for knowledge sources. Model II shows the existence of a positive significant relationship between the *latent innovation* (I^*) and the combination of internal and external sources of knowledge. Although, there is a negative relation between innovation and the size of the firms indicating that a smaller size is more likely for getting a higher level of innovation.

Table 5. Maximum likelihood estimates of the Ordered Probit models.

Variables	Model I			Model II		
	Coefficient ([1])		Sign.([2])	Coefficient ([1])		Sign.([2])
Knowledge Sources Dummies						
Not National Not Foreign	--------					
Only National	0,1878	(0.3862)				
Only Foreign	-0,0447	(0.5444)				
National & Foreign	0,3090	(0.3988)				
Not Internal Not External				--------		
Only Internal				0,4563	(0.3767)	
Only External				0,3803	(0.3279)	
Internal & External				1,3923	(0.3101)	***
Controls						
Size	-0,1863	(0.1590)		-0,2856	(0.1544)	*
Origin of Capital	-0,2310	(0.2609)		-0,1783	(0.2457)	
Export Profile	-0,1247	(0.2528)		0,0672	(0.1426)	
Sector	-0,0447	(0.1485)		0,0258	(0.1595)	
Internal Learning	0,5169	(0.1513)	***			
External Buy of Technology	0,5417	(0.1808)	***			
/cut 1	1,472878	(0.9006)		-0.26675	(0.7068)	
/cut 2	2,489781	(0.9137)		0.70548	(0.7099)	
Log-likelihood	-116.46			-121.7		
Akaike Information Criterion (AIC)	254,91			261,54		
Prob > chi2	0.0007			0.0001		
Perc. of Correct Predictions	0.50			0.52		

([1]) Standard error in parentheses
([2]) *** Significant at 1%; ** Significant at 5%; * Significant at 10%

To perform the test of complementarity and substitutability the dummy variables of knowledge sources of innovation are taken into account. In particular, when the Wald statistic is below 1,642, the correspondently test is accepted, and when the statistic is above 7,094 the test is rejected (Kodde and Palm, 1986). Table 6 shows the tests for the two models.

Table 6. Complementarity and Substitutability Tests. Wald Statistics.

	Model I	Model II
Supermodularity Test	8,17E-31	1,15E-28
Submodularity Test	0,015514	7,64999

Note: The test is accepted if the Wald statistic is below the lower bound at 10% of significance (1,642), and it is rejected if the statistic is above the upper bound (7,094) (Kodde and Palm, 1986).

It can be seen that in Model I, where we are testing the relations between national and foreign linkages, both tests are accepted. The null hypothesis is defined for non strict inequalities, according to this the acceptance led to perform an additional Wald Test as equality to zero. The Chi-Square statistic of the test was 0,0155 accepting the null hypothesis as equality to zero at 10% of significance. This means that firms involved in the two production networks analyzed here are mostly indifferent to recur either to national or foreign linkages as a means complementary to be more likely for getting a higher level of innovation. According to the results of the tests, it is not possible to affirm that there is a strict complementarity relation between these variables, neither a substitutability strict relation. This result does not allow us to accept *H1* in which a complementarity relationship between national and foreign knowledge sources was expected.

It must to be said that we are using incomplete indicators of national and foreign sources, since our indicators focus only on linkages and they leave aside other foreign and national knowledge sources; in particular, embodied knowledge. This can be pointed out as a limitation of the analysis that make harder to provide more general conclusions about the relationship between national and foreign sources of knowledge. Nonetheless, linkages are adopted as proxies for this aspect and the results allow us to give some partial conclusions about the relative impact of internationalization and the still predominant relevance of national sources. Besides the internationalization of production is often viewed as a mechanism to increase the access to foreign sources of knowledge, the results show that foreign linkages does not become strict substitutes of national linkages and these keep their important role for innovation in the production networks of an emerging economy such as Argentina.

On the other hand, Model II addresses the test of the relation between internal and external knowledge sources for innovation. The results obtained in this case are conclusive: the supermodularity test is accepted and the submodularity test is rejected. This indicates that for firms in these production networks, internal and external knowledge sources are complementary to be more likely for getting a higher level of innovation. Moreover, the rejection of a substitutability relation is reinforcing this result and then, it allows us to accept our *H2* that states the existence of complementary relations between internal and external knowledge sources. Also in this case, it can be affirmed that internationalization does not reduce the importance of internal sources either. In sum, these findings tend to support empirically the “Make & Buy” argument in the related literature, confirming the idea that successful innovation requires to complement internal knowledge sources (namely, ‘making technology’) with external knowledge sources (namely, ‘buying technology’), a process that can be of particular relevance in the context of emerging economies.

5. Concluding Remarks

This paper analyzes the existence of complementarity between different sources of knowledge for innovation in firms involved in two production networks in Argentina. This is an issue that has received attention in the innovation literature but most of the evidence has been generated until now with firm level data analysis for developed countries. The production network approach is adopted as a suitable analytical framework of the complementarity in Argentinean firms involved in the automotive and the iron-steel networks and this empirical evidence try to contribute to cover this detected lack in the literature.

Following a previous accepted empirical method applied to the study of complementarity, this analysis introduces also the internationalization issue, including a specific test of the relationship between national and foreign sources of knowledge. Our findings are revealing and confirming that although international markets and activities can reinforce the innovative performance of firms, these linkages not necessarily erode the knowledge sourced locally. On the contrary, the results of this empirical analysis shows evidence of the relevance that still keep the development of internal capabilities in firms as means of the stock of previous knowledge necessary even for the absorption of external know-how, as well as the predominance that the acquisition of embodied knowledge in technology may have for firms in developing contexts. Moreover, this paper corroborates the argument of the contextual aspects for the presence of complementarity between internal and external sources of knowledge enhancing innovation. In particular, the significance of the absorptive capacity notion is an aspect confirmed as it is the specific fact that context matter for understanding the choice of firms to combine diverse knowledge sources as a key driver for the capabilities building process that is desirable in developing economies.

Nonetheless, the complementarity and substitutability tests performed here are based upon dichotomous indicators of recurrence to different types of knowledge sources (i.e.. reflecting if the firm recur to a source, besides how much, or not all, etc.), an aspect that may limit the robustness of the conclusions derived from them. The issue is that firms recur to different sources with some gradualness and these are also combined in diverse degrees. For this reason, this kind of tests allows us to get evidence about the complementarity (or substitutability) relations between the recurrence (or not) to different knowledge sources for innovation, but the findings can be complemented with other techniques (i.e.: multivariate analysis), that permit a better evaluation of the diverse degrees of complementarity associated with a major level of innovation in firms.

APPENDIX: Construction of Indicators

Dependent Variable

Innovation. Ordinal variable. Assumes three modalities (1=low; 2=medium; 3=high). It is composed by two sub-indicators. First a sub-indicator of the Importance of Innovation (II) was constructed. To do it, four sub indicators of the importance of innovations were constructed (Importance of Commercial Innovations, Importance of Product Innovations, Importance of Process Innovations, and Importance of Organizational Innovations), with three modalities: low, medium, and high; which had been valued 1, 2 and 3, respectively. Then, II was constructed adding the values of each sub indicator of importance, and three modalities were developed: low (values 4 to 6), medium (values 7 to 9) and high (values 10 to 12). Secondly, we constructed an overall sub-indicator of the Results of Innovations (RI), regarding the quantity of areas where the innovation generates improvements in the firm (improvements in efficiency of human recourses, in the internal JIT, in the development and improvement of products, product adaptation, development and process improvement, development of new forms of distribution and the organization of the production) with three modalities: low (when the firm obtained results from innovation only in one or none area), medium (when the firm obtained results from innovation in two, three or four areas), and high (when the firm obtained results from innovation in five, six or seven areas). Finally, the overall indicator of **Innovation** takes into account the II and RI indicators, with three modalities: low (II low and RI low, II low and RI medium, II medium and RI low); medium (II medium and RI medium, II low and RI high, II high and RI low); and high (II medium and RI high, II high and RI high, II high and RI medium. This indicator was developed and applied in previous works (Morero, 2010, 2011, 2013).

Independent Variables: Knowledge Sources

To test the hypothesis, binary variables of recurrence to national and foreign knowledge sources, on the one hand, and internal and external knowledge sources, on the other hand. These variables were developed upon basis of four types of knowledge sources to innovation indicators (National Linkages, Foreign Linkages, Internal Learning and External Buy of Technology). Those were developed in previous works (Morero, 2010, 2011, 2013), and are detailed as follows.

Internal Learning. Ordinal Variable. Assumes three modalities (1=low; 2=medium; 3=high). Has two equally weighted components: an indicator of internal Structure of Circulation of Knowledge (SCK) and an indicator of the Intensity of Circulation of Knowledge (ICK). SCK indicator summarizes various aspects related to work process organization, the structure of R & D and training structure. All these sub-indicators have three modalities: low, medium or high, depending on the extent that favors the processes of knowledge circulation. SCK weights 0.20 Work Process Organization, 0.15 R&D Structure and 0.15 Training Structure sub-indicators. The ICK indicator, includes the internal development of technology efforts (R&D expenditures, product development, organizational change, etc.), quality activities and the continuous improvement activities. All these sub-indicators have three modalities (1=low, 2=medium, 3= high). SCK weights 0.20 Efforts in Internal Development of technology, 0.15 Quality Activities and 0.15 Continuous Improvement Activities.

External Buy of technology. Ordinal variable. Assumes three modalities: 3 (high), when the firms has done expenditures on the purchase of capital goods and acquisition of licenses; 2 (medium), when the firms has done expenditures only in one of these items, 1 (low), when the firms has not done expenditures in these items.

National Linkages. Ordinal Variable. Assumes three modalities (1=low; 2=medium; 3=high). Takes into account the intensity of technological linkages of the firms with national actors (cores, other plants, domestic suppliers or customers, industrial chambers, technology centers and universities), measured by the quantity of objectives of the linkages, the frequency of the relations, and the quantity of types of actors who the firms interacts.

International Linkages. Ordinal Variable. Assumes three modalities (1=low; 2=medium; 3=high). Takes into account the intensity of technological linkages of the firms with national actors (other plants, international customers and suppliers, headquarters), measured by the quantity of objectives of the linkages, the frequency of the relations, and the quantity of types of actors who the firms interacts.

To perform the dummy variables of recurrence to national and foreign linkages, the last two variables were used, generating four variables that represent the combination of recurrence to both sources of knowledge.

Not National Not Foreign. Dummy variable. Assumes 1 if the firm has a low a high value on national linkages and on international linkages; 0 otherwise.

Only National Linkages. Dummy variable. Assumes 1 if the firm has a high or medium on national linkages and low on international linkages; 0 otherwise.

Only Foreign Linkages. Dummy variable. Assumes 1 if the firm has a high or medium on international linkages and low on national linkages; 0 otherwise.

National And Foreign. Dummy variable. Assumes 1 if the firm has a high or medium value on national linkages, and a high or medium value on international linkages; 0 otherwise.

To perform the dummy variables of recurrence to internal and external knowledge sources, the indicators of internal learning, external buy of technology, national and international linkages, were used. Analogously, four dummies represent the combination of recurrence to both sources of knowledge for innovation as follows.

Not Internal Not External. Dummy variable. Assumes 1 if the firm has not a high value neither internal leaning, external buy of technology, national linkages, nor international linkages; 0 otherwise

Only Internal. Dummy variable. Assumes 1 if the firm has only a high value on internal leaning; 0 otherwise.

Only External. Dummy variable. Assumes 1 if the firm has a high value on external buy of technology, or national linkages, or international linkages; and not on internal leaning; 0 otherwise.

Internal And External. Dummy variable. Assumes 1 if the firm has a high value on internal leaning and either external buy of technology, or national linkages, or international linkages; 0 otherwise.

Control Variables

Size. Ordinal Variable. Assumes 1 if the firm is small (until annual sales of $ 5 million), 2 if the firm is medium size (between $ 5 million and $ 30 million annual sales), and 3 if it is a large firm (more than $ 30 million annual sales).

Origin of Capital. Adopt 1 if the firm belongs to a foreign corporation; 2 otherwise.

Export Profile. Ordinal variable. Assumes 1 if the firm does not export at all, 2 if the firm exports until the 20% of its sales, and 3 if exports more than 20% of its sales.

Sector. Variable that follow Pavitt Taxonomy. Assumes 1 for supplier dominated sectors, 2 for scale intensive sectors, 3 for specialized suppliers sectors, and 4 for science intensive sectors.

References

Abramovsky, L.; Kremp, E.; López, A.; Schmidt, T. and Simpson, H. 2005. "Understanding Co-Operative R&D Activity: Evidence from Four European Countries."

Albornoz, F.; Milesi, D. and Yoguel, G. 2005. "Knowledge Circulation in Vertically Integrated Production Networks: Cases of the Argentine Automotive and Iron and Steel Industries." *INNOVATION: management, policy & practice*, 7(2-3), 200-21.

Albornoz, F. and Yoguel, G. 2004. "Competitiveness and Production Networks: The Case of the Argentine Automotive Sector." *Industrial and Corporate Change*, 13(4), 619-42.

Alvarez, I. and Molero, J. 2005. "Technology and the Generation of International Knowledge Spillovers: An Application to Spanish Manufacturing Firms." *Research Policy*, 34(9), 1440-52.

Arora, A. and Gambardella, A. 1990. "Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology." *JIE*, 38(4), 361-79.

Arora, A.; Gambardella, A. and Torrisi, S. 2004. "In the Footsteps of Silicon Valley? Indian and Irish Software in the International Division of Labour," T. Bresnahan and A. Gambardella, *Building High Tech Clusters: Silicon Valley and Beyond.* Cambridge: Cambridge University Press,

Arrow, K. 1962. "Economic Welfare and the Allocation of Resources for Invention," R. Nelson, *The Rate and the Direction of Inventive Activity.* Princenton Un. Press, 609-26.

Audretsch, D. B.; Menkveld, A. J. and Thurik, A. R. 1996. "The Decision between Internal and External R & D." *Journal of Institutional and Theoretical Economics (JITE)*, 519-30.

Balzat, M. and Hanusch, H. 2004. "Recent Trends in the Research on National Innovation Systems." *Journal of Evolutionary Economics*, 14(2), 197-210.

Bartholomew, S. 1997. "National Systems of Biotechnology Innovation: Complex Interdependence in the Global System." *Journal of International Business Studies*, 241-66.

Bas, C. L. and Sierra, C. 2002. "'Location Versus Home Country Advantages' in R&D Activities: Some Further Results on Multinationals' Locational Strategies." *Research Policy*, 31(4), 589-609.

Basant, R. and Fikkert, B. 1996. "The Effects of R&D, Foreign Technology Purchase, and Domestic and International Spillovers on Productivity in Indian Firms." *Review of Economics and Statistics*, 78(2), 187-99.

Belderbos, R.; Carree, M.; Diederen, B.; Lokshin, B. and Veugelers, R. 2004a. "Heterogeneity in R&D Cooperation Strategies." *International Journal of Industrial Organization*, 22(8–9), 1237-63.

Belderbos, R.; Carree, M. and Lokshin, B. 2006. "Complementarity in R&D Cooperation Strategies." *Review of Industrial Organization*, 28(4), 401-26.

____. 2004b. "Cooperative R&D and Firm Performance." *Research Policy*, 33(10), 1477-92.

Blonigen, B. A. and Taylor, C. T. 2000. "R&D Intensity and Acquisitions in High-Technology Industries: Evidence from the Us Electronic and Electrical Equipment Industries." *JIE*, 48(1), 47-70.

Braga, H. and Willmore, L. 1991. "Technological Imports and Technological Effort: An Analysis of Their Determinants in Brazilian Firms." *JIE*, 39(4), 421-32.

Cantwell, J. and Piscitello, L. 2000. "Accumulating Technological Competence: Its Changing Impact on Corporate Diversification and Internationalization." *Industrial and Corporate Change*, 9(1), 21-51.

Carlsson, B. 2006. "Internationalization of Innovation Systems: A Survey of the Literature." *Research Policy*, 35(1), 56-67.

Cassiman, B. and Veugelers, R. 2006. "In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition." *Management Science*, 52(1), 68-82.

____**.** 2002. "R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium." *The American Economic Review*, 92(4), 1169-84.

Coase, R. H. 1937. "The Nature of the Firm." *Economica*, 4(16), 386-405.

Cohen, W. and Levinthal, D. 1989. "Innovation and Learning: The Two Faces of R&D." *EJ*, 99(397), 569-96.

Cohen, W. M. and Levinthal, D. A. 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation." *Administrative Science Quarterly*, 128-52.

Chesbrough, H. W. 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business Press.

Chudnovsky, D. 1999. "Science and Technology Policy and the National Innovation System in Argentina." *CEPAL review*, (67), 157-76.

Deolalikar, A. B. and Evenson, R. E. 1989. "Technology Production and Technology Purchase in Indian Industry: An Econometric Analysis." *The Review of Economics and Statistics*, 71(4), 687-92.

Fransman, M. 1999. "Is National Technology Policy Obsolete in a Globalised World? ," M. Fransman, *The Japanese Vision.* Oxford: Oxforf University Press,

Grossman, S. J. and Hart, O. D. 1986. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *The Journal of Political Economy*, 691-719.

Hagedoorn, J. 2002. "Inter-Firm R&D Partnerships: An Overview of Major Trends and Patterns since 1960." *Research Policy*, 31(4), 477-92.

Hagedoorn, J.; Link, A. N. and Vonortas, N. S. 2000. "Research Partnerships." *Research Policy*, 29(4), 567-86.

Hou, J. and Mohnen, P. 2011. "Complementarity between Internal Knowledge Creation and External Knowledge Sourcing: Evidence from Chinese Manufacturing Firms." *UNU-MERIT WP Series*, (#2011-048).

Johnson, B. 1992. "Institutional Learning," B. Å. Lundvall, *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.* London: Printer Ed., 23-44.

Kodde, D. A. and Palm, F. C. 1986. "Wald Criteria for Jointly Testing Equality and Inequality Restrictions." *Econometrica: journal of the Econometric Society*, 1243-48.

Laursen, K. and Salter, A. 2006. "Open for Innovation: The Role of Openness in Explaining Innovation Performance among Uk Manufacturing Firms." *Strategic Management Journal*, 27(2), 131-50.

Lokshin, B.; Belderbos, R. and Carree, M. 2008. "The Productivity Effects of Internal and External R&D: Evidence from a Dynamic Panel Data Model." *Oxford Bulletin of Economics and Statistics*, 70(3), 399-413.

Lopéz, A. 2008. "Determinants of R&D Cooperation: Evidence from Spanish Manufacturing Firms." *International Journal of Industrial Organization*, 26(1), 113-36.

Lundvall, B. Å. 2007. "National Innovation Systems—Analytical Concept and Development Tool." *Industry and innovation*, 14(1), 95-119.

____ ed**.** 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Printer Ed.

Milgrom, P. and Roberts, J. 1995. "The Economics of Modern Manufacturing: Reply." *AER*, 85(4), 997-99.

____**.** 1990. "The Economics of Modern Manufacturing: Technology, Strategy, and Organization." *AER*, 80(3), 511-28.

Miotti, L. and Sachwald, F. 2003. "Co-Operative R&D: Why and with Whom?: An Integrated Framework of Analysis." *Research Policy*, 32(8), 1481-99.

Miravete, E. J. and Pernias, J. C. 2006. "Innovation Complementarity and Scale of Production." *JIE*, 54(1), 1-29.

Mohnen, P. and Röller, L.-H. 2005. "Complementarities in Innovation Policy." *EER*, 49(6), 1431-50.

Morero, H. A. 2013. "Internacionalización Y Sistema Nacional De Innovación Argentino: Una Perspectiva De Tramas Productivas. Los Casos Automotriz Y Siderúrgico," Ph.D. Thesis, U.N.C.,

____**.** 2010. "Internacionalización, Tramas Productivas Y Sistema Nacional De Innovación." *Journal of technology management & innovation*, 5(3), 142-61.

____**.** 2011. "Knowledge Accumulation and Innovation in Internationalized Production Networks: The Automotive and the Iron and Steel Cases," *9th Globelics International Conference.* Buenos Aires, Argentina:

Mowery, D. C. and Oxley, J. E. 1997. "Inward Technology Transfer and Competitiveness: The Role of National Innovation Systems," D. Archibugi and J. Michie, *Technology, Globalisation and Economic Performance.* UK: Cambridge University Press,

Mytelka, L. K. 2000. "Local Systems of Innovation in a Globalized World Economy." *Industry and innovation*, 7(1), 15-32.

Niosi, J. and Bellon, B. 1994. "The Global Interdependence of National Innovation Systems: Evidence, Limits, and Implications." *Technology in Society*, 16(2), 173-97.

Novick, M. and Carillo, J. 2006. "Eslabonamientos Productivos Globales Y Actores Locales: Debates Y Experiencias En América Latina," E. De la Garza Toledo, *Teorías Sociales Y Estudios Del Trabajo: Nuevos Enfoques.* Barcelona: Antrhopos Editorial, 243-67.

Pavitt, K. and Patel, P. 1999. "Global Corporations and National Systems of Innovation: Who Dominates Whom," D. Archibugi, J. Howels and J. Michie, *Innovation policy in a global economy.* UK: Cambridge University Press, 94-119.

Pisano, G. P. 1990. "The R&D Boundaries of the Firm: An Empirical Analysis." *Administrative Science Quarterly*, 153-76.

Poma, L. 2000. "La Nueva Competencia Territorial: Territorio Y Competitividad De Las Empresas–El Rol De Las Instituciones En El Espacio Global," F. Boscherini and L. Poma, *Territorio, Conocimiento Y Competitividad De Las Empresas: El Rol De Las Instituciones En El Espacio Global.* Buenos Aires: Editorial Miño y Dávila,

Schmiedeberg, C. 2008. "Complementarities of Innovation Activities: An Empirical Analysis of the German Manufacturing Sector." *Research Policy*, 37(9), 1492-503.

Serrano-Bedia, A. M.; López-Fernández, M. C. and García-Piqueres, G. 2012. "Complementarity between Innovation Activities and Innovation Performance: Evidence from Spanish Innovative Firms." *Journal of Manufacturing Technology Management*, 23(5), 557-77.

Teece, D. J. 1986. "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy." *RP*, 15(6), 285-305.

Teece, D. J.; Pisano, G. and Shuen, A. 1997. "Dynamic Capabilities and Strategic Management." *Strategic Management Journal*, 18(7), 509-33.

Topkis, D. M. 1998. *Supermodularity and Complementarity*. Princeton Univ Pr.

Von Hippel, E. 2007. *The Sources of Innovation*. Springer.

Williamson, O. 1985. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. NY.