The Environment in the Development of Firms' Innovative Capacities

Argentine Industrial SMEs from Different Local Systems

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by

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The environment in the development of firms' innovative capacities: Argentine industrial SMEs from different local systems*

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Abstract:
The new economic scenario increases the importance of the "innovative capacity" of the agents as crucial competitive instrument in order to attain the differentiating element required by the competitive process. Innovative capacity refers to the agents' capability to transform general knowledge into specific one using their stock of competencies and dynamic assets, including formal and informal –both codified and tacit- learning.

In this paper we recognize that the economic, social and institutional environment of firms becomes increasingly important. The new competitive situation and the uncertainties generated by the economic globalization process intensify the role of institutional and social agents in strengthening the innovative capacity of firms. This, in turn, results in the generation of technological, organizational and market knowledge and in the development of formal and informal mechanisms to facilitate its diffusion through the productive internal network. In the framework defined by the new production and market conditions, innovative processes change from an individual (and often incremental) phenomenon to a collective one where both the capacity to collaborate and interact and the adequate institutional structure, fostering innovative activities on the part of economic agents, become crucial.

The main objective of this paper is to present a *proxy* indicator of the agents' potentiality to learn, create "competencies", transform generic knowledge into specific knowledge and, therefore, innovate. It aims at analyzing the knowledge of firms, specially, the way they acquire, organize, memorize and transfer information (technical, organizational, etc.) thus contributing to increase the knowledge base itself.

For that purpose, this paper analyze the application of such indicator to a sample of 245 firms in Argentina, most of them small and medium sized firms, located in different areas with heterogeneous incidence of externalities. In that sense, we will try to determine the importance of the agent's size and environment to understand the existing differences in innovative capacities. Finally, the paper will evaluate whether those firms with larger innovative capacity have had a more dynamic performance in the market as from the start of the trade openness and structural reforms processes.

Keywords: Learning, systems of innovation, competences knowledge

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* This document is based on Yoguel (2000), Boscherini et al. (1998), Kweitel and Yoguel (1998); Moori-Koenig and Yoguel (1998), Alegre et al. (1997) and Boscherini and Yoguel (1996).

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Introduction

Over the last two decades the international economic scenario has experienced major transformations. The globalization process and a combination of different elements such as the new technological and organizational standards, the volatility of demand and the segmentation of markets, the possibility of combining scales, the reduction in the life-cycle of products and the strategic uncertainties related to this new scenery have posed an increased competitive pressure on economic agents. As a consequence of the above changes, the notion of competitiveness as a macroeconomic and sectoral phenomenon, determined by static comparative advantages has been questioned. In the framework of this new global competition, competitiveness becomes a systemic phenomenon adding further aspects to the traditional macroeconomic and sectoral factors. The endogenous capacity of agents and the development of the economic and social environment in which they operate, have become key elements in the creation of competitive advantages.

Furthermore, this new competitive design has increased the importance of the creation of competitive advantages and the response of firms aiming at enhancing products and processes development, implementing organizational changes and developing new links through the market. Agents try to increase what we will call their "innovative capacity" in order to attain the differentiating element required by the competitive process. Innovative capacity refers to the agents' capability to transform general knowledge into specific one using their stock of competencies and dynamic assets, including formal and informal – both codified and tacit- learning (Ernst and Lundvall, 1997; Lall, 1995; Boscherini and Yoguel, 1996). The competencies stock may be defined as the set of knowledge, routines and technological -formal and informal- organizational skills available for a firm to carry out the mentioned development. In that sense, these competencies are not limited to information or equipment but they include organizational capabilities, and behavior and routine standards affecting the decision making process (Garcia, 1995) and the innovative development of firms.

These new concepts are drawn from the notion that comparative advantages may be created and, therefore, have a dynamic nature. In the transit from static to dynamic comparative advantages, technology, learning processes and the increase of innovative capacity play a key role. Thus, the agent's learning capacity -defined as an interactive social process- and the development of technical capabilities prove vital for the economic success of firms, regions and countries (Ernst and Lundvall, 1997).

In this context, the economic, social and institutional environment of firms becomes increasingly important. The new competitive situation and the uncertainties generated by the economic globalization process intensify the role of institutional and social agents in strengthening the innovative capacity of firms. This, in turn, results in the generation of technological, organizational and market knowledge and in the development of formal and informal mechanisms to facilitate its diffusion through the productive internal network. In the framework defined by the new production and market conditions, innovative processes change from an individual (and often incremental) phenomenon to a collective phenomenon where both the capacity to collaborate and interact and the

adequate institutional structure, fostering innovative activities on the part of economic agents, become crucial.

The main objective of this paper is to present a *proxy* indicator of the agents' potentiality to learn, create "competencies", transform generic knowledge into specific knowledge and, therefore, innovate. It aims at analyzing the knowledge of firms, specially, the way they acquire, organize, memorize and transfer information (technical, organizational, etc.) thus contributing to increase the knowledge base itself.

For that purpose, this paper will analyze the application of such indicator to a sample of 245 firms, most of them small and medium sized firms, located in areas with heterogeneous incidence of externalities. In that sense, we will try to determine the importance of the agent's size and environment to understand the existing differences in innovative capacities. Finally, the paper will evaluate whether those firms with larger innovative capacity have had a more dynamic performance in the market as from the start of the trade openness and structural reforms processes.

The analysis presented in this work is based on the following basic notions: Firstly, "*a small or medium sized firm is not a large firm of small size*" (Storey, 1986). In that sense, a distinctive feature of these agents is that their ownership and management are intertwined in such a way that the characteristics of this type of firms are closely related to those of their owners. Secondly, it is accepted that these agents operate with limited rationality and less than perfect information; therefore, they approach the economic scenario with a degree of uncertainty that cannot be modeled. Thirdly, even if it is accepted that there are sectoral differences in the firms' development of competencies, this work assumes a theoretical approach that focuses on intrasectoral differences. Thus, it considers that given external shocks, it is probable that the firms' evolutionary paths be different (Nelson, 1991). Firms decode uncertainties according to their history, to their initial capacities, to their relationship with the environment in which they operate and its level of development –in terms of generation of different types of externalities. In fourth place, the work emphasizes that, even if local environment may, in positive cases, favor the development of the agents' innovative capacities and turn into a quasi-market operator reducing dynamic uncertainties, overcoming the weakness of their organizational strategy, strengthening learning processes and providing missing competencies (Camagni, 1991), the differences in the evolutionary paths are still very important. Therefore, it is likely that even in the most developed areas there should be huge differences in the development of innovative capacities on the part of the agents. Finally, the characteristics associated to technological progress (specificity, cumulative capacity, path dependence, irreversibility) do not necessarily lead innovative activities to a "real" evolution and development. The innovative activities of a firm are a "discovery" process in which there is no possibility of forecasting the potential results and, therefore, there is no possibility of assigning them any degree of probability. Furthermore, such a process is characterized by its unpredictable nature (Dosi, 1988). In that sense, in the framework of each technological paradigm there are many "technological trajectories", each of them defining a potential direction for the innovative activities carried out by the firms. The election of a given trajectory will depend on the interaction of the innovative

process and the economic, social and institutional environment which function as a "selection tool" among alternative trajectories.

The central hypothesis underlying this work states that, even though in those areas where externalities have more incidence the firms' average innovative capacity is greater than in those were the environment operates negatively, there are differentiating processes strongly influenced by the agents' size. Size represents a differentiating factor in terms of behavior, regardless of the development of the local system. This general hypothesis is supplemented with others stating: (i) in those environments where there are positive externalities, size does not constitute a differentiating factor for innovative capacities and (ii) for the firms to profit from externalities generated by a positive context, a minimum threshold of competencies is required. Otherwise, they would not be able to enhance their learning processes, transform generic knowledge into specific knowledge and obtain "positive outcomes". Firms must have a certain size to attain such minimum threshold of competencies, structure and organization. Once that threshold is reached, their innovative capacity will be influenced by the above mentioned factors: their evolutionary path, learning capacity and level of development of the context in which they operate.

These hypotheses are contrasted against a data base which includes the aggregate outcomes of four recent researches on the innovative capacity development of Argentine Small and Medium Enterprises (Boscherini and Yoguel, 1996; Boscherini et al., 1998; Alegre et al., 1997; Moori-Koenig and Yoguel, 1998) in areas with different levels of externalities generation.

The first section of this paper presents the theoretical framework of the analysis. In the second part, the general characteristics of the indicator used to estimate the innovative capacity of agents are discussed. The third section contains the main hypothesis and some additional theoretical elements on the microeconomics factors implicit in the interpretation of the firms' answers. The fourth section presents the aggregate results corresponding to 245 agents –mostly SMEs- in geographical areas with different levels of externalities generation. In the fifth section there are some models analyzing the existing association among the development of innovative capacity, the development of local environment and the size of the agents. These models allow the evaluation of the above hypotheses. Finally, in the sixth section the main conclusions are presented.

1. Technology, knowledge generation and firms: An approximation to the innovative capacity of firms

The linkage between technology and the development of learning processes has acquired an increasing importance in the economic theory of the last years. In this context, the "main stream" theoretical framework –the standard neo-classical economic theory- is based on a notion which states that economic agents are maximizing subjects operating with perfect rationality and information, in a reliable environment, and have rational expectations. In this framework, capital is considered malleable –jelly models- and technology is described as a set of productive techniques, which may be selected and captured at no cost by agents in terms of the existing relationship between profit and salary rates (Solow, 1963). Therefore, technology may be compared to a library including the whole set of knowledge available to agents. It is assumed that, at the moment of choosing the best techniques, agents take into account the "state of the art" of the library and the current profit-benefit ratio. Thus, when they change from high profit-salary relationships to lower ones, agents change their work-intensive techniques for capital-intensive ones. In this context, it is assumed that there is an order of techniques related to the decreasing output of factors and that the limits of prices corresponding to each selected technique are cut once in the sense forecasted for a production function with decreasing outputs (Samuelson,1962). Consequently, a work-intensive technique selected at a high level of benefit rate could not be used at a lower rate, thus preventing the possibility of changing techniques (Sraffa, 1960). It is worth mentioning that both the election of techniques and their displacement in case of changes in income distribution were instantaneous and, therefore, no learning process was involved. In this standard neo-classical framework, which survived the old discussion on capital theory[1], technical progress was considered as separated from the production function and independent of capital accumulation. Therefore, the acquisition of knowledge and the learning process of agents: (i) did not represent a valid argument incorporated to the production function and (ii) it was independent of the agents' capital stock. Even though some models incorporated the notion that there are learning curves to which the displacement of the production function is attached –independent technical progress- this learning is considered exogenous and independent of production factors (specially capital stock) and, therefore, does not have any influence on them.

The theory's lack of empiric evidence to explain changes originating in the productive structure brought about further developments which –in the framework of the new theory of international trade and growth theory- changed some of the assumptions of the

[1] Nevertheless, Samuelson (1962) granted that "the simple story of Jevons, Böhm-Bawerk, Wicksell and other neoclassical authors, which stated that as the interest rate decreased due to a lack of present consumption in favor of future consumption, technology should turn more indirect, mechanized and productive, could not be universally valid". By the end of his work, he acknowledges that the critics of Pasinetti, Morishima, Garegnani and others are to be appreciated since they have demonstrated that reversion is a logical possibility of any technology. In a rare demonstration of intellectual honesty, Samuelson states that "if this brings trouble to those who still sigh for the old parables of the neo-classical theory, we should remind them that the academician's life was not meant to be easy. We should respect and evaluate all events of life".

standard neo-classical model. Grossman and Helpmann (1992), for example, developed a growth theory which internalizes the technical progress in the production function and shows that the strategic interaction among agents, the R&D activities; the existence of scale economies and the learning processes are crucial for the creation of competitive advantages and help explain the specialization pattern of agents dealing with international trade. Based on a general equilibrium model, they consider that the agents' decisions of investing on R&D and the benefits of the resulting innovations depend on the operating conditions of the markets. Thus, endogenous knowledge cumulative process generates productivity returns supporting the firm's growth. In this theoretical context, knowledge process is limited to those formal processes developed in R&D laboratories.

Nevertheless, the most important step in the sense of incorporating explicit knowledge into the theory started with the different neo-Schumpeterians and evolutionary theories, which take some distance from the general equilibrium theory and implicitly accept the existence of transactions performed under unbalanced conditions. These theories are based on a different conception of firm and technology, and assign a key role to formal or informal learning processes carried out by agents in the generation of comparative advantages. Thus, the starting point is a theory which includes the limited rationality of agents, their less than perfect access to information and the uncertainty of the economic context in which they operate. This uncertainty, which constitutes a key element for the analysis, becomes a standard that agents cannot express in probabilistic terms: the incomplete information cannot be completed and agents must make their decisions in that context. From this viewpoint, the learning capacity -understood as a socially embedded interactive process- and the development of agents' competencies determine the economic success of firms, regions and countries (Ernst and Lundvall, 1997). Consequently, the potentiality of agents to transform generic knowledge into specific knowledge –"the development of their innovative capacitity (Lall, 1992; Boscherini and Yoguel, 1996)"- clearly affects the possibilities of generating competitive advantages and, to some extent, diminishing strategic uncertainties present in the markets in which they operate. These theories are based upon the notion that a minimum threshold of capacities and competencies is necessary to generate these learning processes (Rullani, 1997). Such threshold is less significant in those "environments" and countries where there are positive externalities and the National Innovation System operates adequately.

A specific feature of learning is that it cannot be completely explicit and, therefore, it cannot always be transformed into information as a transable good (Dal Bó and Kosacoff, 1998). This characteristic incorporates strong specificities in the conception of technology, which is now starting to be considered as a complex system for generating and transmitting the codified and tacit knowledge accumulated by the firm (Ernst and Lundvall, 1997; Bell and Pavitt, 1995), rather than a set of machines and production techniques[2].

[2] This level of analysis is associated with the neo-classical approach stating that technology is a set of capital goods and production processes incorporated to the machinery or totally transferable through manuals. From that viewpoint, technological change is the process by which economies change over time as regards the products they produce and the process used to manufacture them (Arrow, 1979; Stoneman, 1995).

On the other hand, this concept of technology includes two levels which were not present in the neo-classical approach (Metcalfe, 1992). Firstly, it incorporates the analysis of individuals' competencies and capacities (knowledge, routines, procedures, abilities, know-how) generated inside the organization. These capabilities go beyond the technical and engineering knowledge stock; they include organizational and management issues related to the development of the productive process (David, 1985). Technical progress consists of a set of incremental innovations, which are now more significant than in the previous period-; the largest innovations supplementing the previous ones. These improvements allow the production of a greater, qualitatively superior output, with a limited amount of resources and in a more efficient way. Furthermore, this concept incorporates knowledge and reasoning capacity as part of technology. Authors dealing with technological trajectories and paradigms (Utterback and Abernathy, 1995; Freeman, 1974; Perez, 1985) consider that the technical development carried out by the firm is based on the equipment, inputs and capacities incorporated into individuals and organizations. These elements, along with the "technical common sense" (Perez, 1983), allow the agents to perform incremental developments in the current technology trajectory or dramatic changes in those sectors that have not reached the optimum technological standard yet.

From that point of view, firms do not select an optimum technique from their technical knowledge library, but they make selection and adjustment efforts which require minimum thresholds of codified and, specially, tacit knowledge. While the codified element in the knowledge process is basically transable, the tacit element is firm-specific, that is, it cannot be acquired in the market and constitutes a key element in terms of the technological differences and competitive advantages of firms (Ernst, 1996; Lall, 1995). Coded elements include a set of organizational and technological knowledge (types of material, machines, components and final products), and they are transmissible by communicative interaction (internet, courses, etc.) through the market (Becattini and Rullani, 1993)[3]. In turn, tacit knowledge implies: (i) knowledge not codified in technology manuals applied to work processes; (ii) general and behavioral knowledge; (iii) capacity for solving non-coded problems; (iv) capacity for linking situations and interacting with other human resources. Summarizing, tacit knowledge allows a complex mental representation of the work process. This type of attribute which cannot be articulated or completely formalized, is strongly affected by context (Mertens, 1997). It is acquired in different situations such as working places, associations, informal meetings, etc. (Ducatel, 1998)[4].

[3] This knowledge may be compared to what Lundvall and Johnson call Know-What and Know-Why. While the first type of knowledge may be classified as events –information-, the second type is of a scientific nature and refers to principles and laws of movement in nature. Both types of knowledge, basically codified knowledge, may be acquired through the market from books, courses, data bases and other sources.

[4] According to Lundvall and Johnson (1994), tacit knowledge includes known terms such as Know-how and Know-who. The first one refers to the skills acquired through direct experience in production and management activities (learning by doing), among others. The second one corresponds to the type of knowledge developed and maintained within the individual firm's limits (appropriability) or embodied in research teams.

When codified knowledge is available to all agents, it does not become a differentiating element in terms of behavior and performance. On the other hand, if codified knowledge is not available to all agents due to (i) less than perfect information; (ii) lack of minimum competencies required; or (iii) lack of minimum tacit knowledge to capture codified knowledge; the unequal access to codified knowledge can also constitute a differentiating element as regards strategic behavior.

Furthermore, the available tacit knowledge becomes a necessary condition to use codified knowledge. Thus, for example, to reach the levels set for the capital team, it is necessary to develop learning processes –with non-predictable curves- which allow firms to enhance products and processes, introduce organizational changes and increase the complexity of their linkage with the local system (Lall, 1995). Therefore, the operation of codified knowledge (interpretation of engineering and design manuals, introduction to general scientific and management knowledge, specification of quality assuring criteria, etc.), requires an underlying tacit knowledge found in organizational routines and collective experience of specific work teams such as R&D, marketing, production and management groups (Ernst and Lundvall, 1997). The vital role of tacit knowledge is also acknowledged by those authors who state that knowledge development –embedded in social networks- depends on the ability embodied in individuals to recognize similitudes (Nightingale, 1996)[5]. In that sense, learning is not an accumulation of information but the recognition of behaviors and relations among memories, which depends on knowledge accumulated through experience and on the automatic capability of individuals to link experiences to that knowledge.

Also, the development of codified intra-firm knowledge and the replication of experimental outcomes depend on the degree of development of tacit knowledge and the existing relationships with other agents and scientific and technological institutions supplementing missing competencies (Ducatel, 1988). Specially, when there is limited rationality on the part of agents, less than perfect information and non-modeling uncertainty, the existence of previous tacit elements becomes a necessary conditions for the development and incorporation of codified knowledge. Besides, tacit knowledge originates in the complexity and quality variations, and prevails in situations in which it is necessary to use different human senses and associate different parameters simultaneously. Therefore, it also requires minimum previous codified knowledge. In this framework, both the globalization process and information technologies increase the agents' strategic uncertainty and strengthen the reasons for developing tacit knowledge (Ducatel, 1988).

The development of intra-firm tacit competencies constitutes an intangible asset which is difficult to transfer and copy and, therefore, it may have a positive effect on the creation

[5] According to Nightingale (1996), tacit knowledge is vital to understand the meaning of the word *"cut"* in sentences such as a) cut a cake and b) cut the grass. Even if the word *cut* is used in the same way in (a) and (b), what is associated to "*cut*" differs in each context. Thus, in each case the word *cut* has a meaning that depends on the experimental knowledge previously accumulated (tacit) which, in turn, varies among different subjects. Namely, the meaning of *cut* is more associated with previous tacit knowledge than to the meaning of the word in isolation.

of competitive advantages and on the agents' performance. Thus, the lack of tacit knowledge may become a barrier for agents to enter the market.

Some authors suggest that the level of relationship reached by codified and tacit knowledge decisively affects the efficiency of the firm's learning process. In turn, these learning processes, generated in sectors with different levels of technological development, do not only involve formal training and development activities but a series of informal –and often unconscious- training and development activities as well. These different learning processes accumulate throughout the agents' trajectory, and participate in the construction of tangible and intangible assets which are crucial in the competence process. However, these assets are not permanent, since they must be contrasted in the competitive process. Whilst some assets do not meet the minimum threshold required and become "devaluated", others emerge as winners and configure the elements of the prevalent technological pattern.

It is worth noting that, from this viewpoint, knowledge may be identified as a production factor with some peculiarities that differentiates it from the neo-classical analysis: i) knowledge generation increases with its consumption; ii) there is no *ex ante* element leading to the assumption that its production is generated under decreasing performances.

In the above analytical context, the concept of innovation is based on a broad vision including a series of interrelated changes which originate in different areas of the firm and aim at enhancing its competitiveness and economic efficiency. Therefore, innovation includes not only isolated activities oriented to develop new products and processes, but the set of incremental developments and updates performed in different areas (organization, marketing, production, etc.) and the activities seeking quality development as well. Besides the mentioned development activities, innovations are generated from different routine activities which are not necessarily related to the production department of a firm (Ernst and Lundvall, 1997). Interaction among workers, the continuous exchange of opinions to solve problems or new challenges and the resulting solutions used to enhance the economic efficiency of the firm, constitute a relevant source of inputs for the development of innovative activities (Boscherini and Yoguel, 1996).

Different types of knowledge and capacities existing in the different areas of the firm converge in the "innovative capacity" aimed at attaining quasi-profits or maintaining the position of enterprises in the market. The possibility of profiting from such knowledge and capacities will depend –specially in the case of SMEs- on the organizational culture of the firm. The intra-firm production and development of that knowledge is a dynamic, continuous and cumulative process, which modifies and reproduces static organizational and technological competencies. Thus, learning -both individual and collective- plays a central role and causes competencies to be dynamic resources which can be modeled according to the firm's strategic vision. Over time, the interaction of this set of factors generates a patrimony of competencies, in many cases intangible and firm-specific (Prahalad and Hamel, 1990) which determine and condition their innovative capacity.

Therefore, going further into the analysis, the innovative capacity of agents may be conceptualized as their potentiality to transform general knowledge into specific knowledge based on formal and informal learning processes which allow them to increase their competencies and competitive advantages. This process is represented in the capacity attained by the SME to develop and enhance products and processes, implement organizational changes and develop new forms of relationship with the market. In that sense, such potentiality implies much more than differential efforts performed in formal R&D laboratories. It involves incremental activities developed throughout the organization, constituting the so-called spread innovative activities (Lassini, 1992).

As mentioned, these answers are originated in a context of limited rationality, less than perfect information and strategic uncertainties which cannot be modeled in the competitive environment in which agents operate. Even if the development of innovative capacities is considered to decrease the risk for agents to lose their position in the market, those features determine that only ex post the agents may be able to confirm if the performed developments were well targeted[6].

In the development of innovative capacity converge, on the one hand, elements belonging to the microeconomic level, such as management style, personal attitude, educational background, entrepreneurial and risk-taking characteristics of the owners, the dynamic accumulation of tangible and intangible assets of firms and learning processes. On the other hand, the environment –defined as a set of institutions, agents and their network relationships- affects decisively the degree of development of innovative activities, conceived as a social and interactive process in a specific and systemic environment (Jonhson and Lundvall, 1994). The importance of innovation activities developed by institutions, their diffusion and the decoding process of their outputs on the part of the firms, determine the environment in which those activities will be performed.

The environment may have a wide range of variation and its influence upon firms is not always positive. Thus, for example, in some environments, institutions and agents are loosely related and there is neither an adequate diffusion of information nor mechanisms favoring the exchange of experiences among involved agents. In this situation, the circulation of tacit and codified knowledge is reduced and, in general, such an environment promotes introvert individual developments. These characteristics –often affected by technical issues and minimum scales problems- determine an innovative performance which is not enough for firms' to enhance their competitiveness. In this situation, a weak environment means constraints that reinforce high pressure competitive situations as a result of the speed of technological change, trade openness and globalization processes. Furthermore, it opposes innovative developments generated in environments where there are articulated institutions and a strong interaction among involved agents. Networking environments, on the other hand, favors the diffusion of knowledge and developments which, in turn, significantly increases the possibility for firms to use them and optimize the efficiency of their innovative activities (Lassini, 1992;

[6] In that sense, market "selection" errors sometimes determine the destruction of non-progressive capacities.

Marlerba, 1993; Nelson, 1993). This last set of element, which affects the firms' innovative capacity and the differentiation of entrepreneurial behaviors, depends on the level of development of what the neo-Schumpeterian literature calls "National System of Innovation" (Nelson, 1993).

Thus, in an analytical framework in which the agents' behavior does not correspond to what is expected by the main stream, and where technology is not limited to the purchase of equipment with codified information, the cognitive factors and the development of formal and informal learning processes acquire a crucial role in the development of innovative capacity and, therefore, in the competitiveness of agents[7].

From this viewpoint, the firm may be considered as a "cognitive system", its main function being the learning process. Furthermore, in the context of market globalization and strong increase of the technological content of productive and organizational processes, there has appeared the need of handling increasingly complex and articulated information flows and relationship circuits, which assigns vital importance to creation and knowledge diffusion activities.

However, the knowledge used in productive and organizational processes coincides neither with the know-how directly generated by learning processes, nor with scientific languages. According to recent literature (Nonaka, 1994; Rullani, 1994), the "value of knowledge" is generated by the continuous translation of scientific-technological languages (formal knowledge circulating through global networks) and empiric-contextual knowledge (tacit knowledge embedded in local productive traditions): the convergence and exchange between these two levels of cognitive elaboration, brought about by knowledge socializing activities, generate innovative processes.

The activity of knowledge socialization, i.e. the exchange of know-how through methods that do not use coded languages but the imitation and informal communications based on tacit knowledge and relationships, is characteristic of the learning processes developing among small firms. In that sense, in these situations there are conditions favoring innovation (autonomy in decision making processes, high degree of information, sharing of experience base, mutual trust, possibility of reaching wide diffusion of the benefits resulting from innovative activities among different agents) (Nonaka, 1994).

The increment of codified knowledge processes brought about by information technologies does not diminish the relevance of tacit knowledge for the economic activity; rather, it increases its importance and eliminates the traditional dichotomy between collective and individual knowledge. According to Lundvall (1992), based on

[7] The analytic framework presented in this section differs significantly from the popperian view, according to which it is not possible to learn from the basis of denied hypotheses without using inductive methods explicitly left aside by Popper. In turn, a learning process such as this seems to fit more into a Lamarckian instruction that into a Darwinian evolution (Gomez, 1995). On the other hand, the development of the knowledge process presented here results from the interaction of scientific knowledge and other increasingly important type of knowledge that does not form part of the episteme and that can include different rational and irrational elements which, in turn, "may be part of a promising research program (Lakatos, 1983)."

the definition of four types of different knowledge used in learning processes (know-what, know-why, know-how and know-who), it is the know-who the one that implies the creation of special social relationships among involved agents, allowing them to take hold of and use their knowledge efficiently. Although Lundvall considers that the know-who knowledge is the most internal and closely related to organizations, the social and inter-organizational dimension of exchanges between different knowledge types, taking place within firms and among them, constitutes a factor which fosters learning processes (Corò, 1997).

However, for a learning process to be complete, there is an increasing need to reach the networks producing and transmitting scientific and technological knowledge. This need reveals the demand for collective investments oriented towards favoring innovative activities and technological transference processes.

Finally, an output of the increasing importance of tacit aspects in the learning process has been the crisis of traditional methods for measuring innovative activities, which are generally focused on proxy variables of formal aspects of learning in organizations. These variables estimate mainly the amount spent in R&D laboratories and patent development (Malerba, 1993; Archibugi and Evangelista, 1993; Acs and Audresch, 1988; Lassini, 1992; Malerba y Orsenigo, 1993, Boscherini and Yoguel, 1996)[8]. Thus, since most indicators of knowledge intensity refer to formal education and to R&D efforts, the resulting image of learning economy is biased and does not reflect the importance of incremental innovation processes throughout the organization. In that sense, it is necessary to use alternative qualitative and quantitative indicators and the notion that innovative capacity is spread throughout the organization in order to capture the development of tacit and codified knowledge which is not focused on R&D specific units (Lassini, 1992). In Argentina, Bosherini and Yoguel, 1996; Boscherini et al., 1997; Alegre et al., 1997, Moori-Koenig and Yoguel, 1997, have made progresses in that direction. As explained in the following section, to capture this set of factors it is necessary to use a more complex indicator encompassing elements which take into account the development of competencies on the part of agents.

2. Estimating an empirically testable indicator of the innovative capacity of agents

This section presents an indicator of the innovative capacity of agents based on the notion that the generation and circulation –either internal or among firms- of knowledge is a complex process which intensity depends on: i) the need to solve concrete problems in an

[8] Major critics on traditional indicators stated that: i) the association between R&D expenditures and the performance of firms was weak and seemed to oppose the increasing importance of knowledge economy; ii) expenditure in R&D does not account for the stock of accumulated innovative activities but for the resources flow; iii) the use of R&D expenditures to estimate the level of development of innovative capacities was based on the notion that all agents are equally efficient as regards their expenditures, which seems hard to accept taking into consideration that agents have different levels of limited rationality and; iv) they underestimate the knowledge firms obtain through other channels (interaction, tacit knowledge, imitation, etc.). From the point of view of patents, critics were focused on the fact that an invention does not necessarily ends up as an innovation

uncertain situation; ii) the demand for non-coded solutions; iii) the level of technical complexity of work teams; iv) the type of basic competencies of agents; v) their ability to share information and work in groups; and vi) the extent in which the agents profit from the workers' technical and organizational knowledge.

The generation and diffusion of codified and tacit knowledge would be positively associated to the characteristics of the human resources of the firm, to the way they organize the work process[9] and to the importance they attach to the interpretation of, and adaptation to, external codified knowledge. The purpose is to estimate the additional development the firm achieves from the goods and service it purchases or gets coded and from the human resources it hires. This set of factors turns tacit knowledge into specific elements which cannot be appropriated by other agents (i.e. lay-out changes, adjustments of soft technologies, adjustments of information destined to products and processes development).

In the particular case of internal tacit knowledge diffusion, the key factor is the existence of networks and different types of relationships among agents. Therefore, given the mentioned conceptualization of the agents' innovative capacity in the design of the indicator, the objective is to evaluate: i) the development of agents' competencies and ii) the degree of knowledge circulation based on formal and informal linkages developed with other agents and institutions.

Since it is assumed that agents have a limited rationality –which is also taken into consideration when analyzing their answers- and that most SMEs focuses management and ownership in one person – the owner- it is concluded that the accuracy of measurements supported by non-continuous quantitative variables is significantly greater than the one resulting from continuous variables. That is, it is assumed that entrepreneurs have a global notion on the approached issues which is much more accurate for estimating the interval for a given variable (training hours, number of people involved in training courses, sales, weight of new products in terms of sales, etc.), than the attempt to know the exact value of the variable[10].

To summarize, in the construction of the factors which form part of the indicator to be presented here, it was assumed that it was better to use non-continuous quantitative variables. The idea is to turn qualitative data in non-continuous quantitative data so as to: i) reduce the non-sample error existing in the observations; and ii) test work hypotheses using econometric techniques.

It is also accepted that, due to the characteristics of the innovation process, firms may identify a nucleus of human resources spread throughout the organization, which is in charge of most incremental developments. Even though the quantitative and qualitative

[9] Degree of flexibility, type of hierarchy, presence of cells, relationship between individual salaries and the performance of the team to which he belongs.

[10] This consideration goes beyond the issue of information confidentiality. Different tests have been undertaken in various surveys, in a series of interviewed firms, at different moments, as regards a number of questions associated with their operation. In most cases, the sales volume for a given year fell in the same interval but differed in the absolute value informed.

importance of such nucleus, and the level of qualification of human resources is crucial, the quality assurance processes, the level of diffusion of training processes and the possibilities of specifying codified knowledge resulting from the participation of the firm in different networks of agents also affects the type of developments carried out by the firm.

In that sense, an indicator of the innovative capacity of firms should involve an estimation of the influence and externalities generated by the economic, social and institutional environment, in which firms they operate. Thus, the addition of variables such as the ones that will be mentioned in the following paragraphs, related to the cooperation performed by the firm with other agents of the same economic environment constitute a proxy of the environment's performance.

The agents' innovative capacity indicator constitutes an average of six factors. There are four factors associated with competence development: *quality assurance, training efforts, scope of development activities and participation of engineers and technicians in the development team*. Additionally, another factor aimed at measuring the *innovative product* is considered. Finally, there is another *proxy variable on the degree of circulation of tacit and codified knowledge and the level of reciprocal trust among agents* (public and private institutions, firms, universities, technological centers, etc.). This factor evaluates the articulation of agents through processes of formal and informal technological cooperation, which constitutes an estimation of "quality" and "positive and negative" capacity of the environment where the firm operates[11].

Thus, the indicator of the innovative capacity of an agent *j (ICIj)* may be expressed like this:

$$ICIj = \sum \alpha i * Fij$$

Where $\alpha\ i$ are the values assigned to each of the factors (Fi), which take the values presented in Box 1. The high aggregated value assigned to the four factors associated to the development of competencies on the part of agents, is directly drawn from the theoretical framework explained in the previous section. Additionally, it was proved that the classification of firms according to their innovative capacity is not significantly modified by changes in the values assigned to factors (Boscherini and Yoguel, 1996).

Box 1. Estimation of factors corresponding to the index of innovative capacity

Factor	Value
Personnel Training Efforts	0.25
Quality assurance activities	0.25
Scope of development activities	0.20
Weight of engineers in development teams	0.07
Weight of new products in billing	0.08
Formal and informal technological cooperation	0.15

[11] This indicator was used in several previous researches that, in general, share common comparative criteria: Boscherini et al. (1998), Boscherini and Yoguel (1996); Alegre et al. (1997), Moori-Koenig and Yoguel (1998).

Thus, each of the above factors that constitutes the innovative capacity index is estimated in absolute terms, using a non-continuous quantitative variable which trajectory – exogenously determined- ranges from a minimum level (1) to a maximum level which, in most cases, is 5. In the Methodological Appendix, the construction of each of the six factors and the questions used for field work are presented.

The way each of the factors which form part of the innovative capacity index was constructed is explained below, making a distinction among those associated to the development of competencies, those related to the innovative product and those corresponding to the circulation of tacit and codified knowledge.

i) Factors associated to the development of competencies

The "**efforts on personnel training**" performed by the firm and directed towards the development of technical competencies was estimated using estimates of the ratio of personnel involved in courses aiming at assuring quality and seeking new developments. The values assigned to the indicator are the following:

4 more than 50% of employees was involved in courses oriented towards quality development and engaged in courses to undertake development activities in the last three years;
3 between 21% and 49% of employees was involved in courses oriented towards quality development and engaged in courses to undertake development activities;
2 between 21% and 49% of employees was involved in courses oriented towards quality development but was not engaged in courses to undertake development activities;
1 less than 20% of employees was involved in courses oriented towards quality development

The **degree of quality assurance** factor reached by the firms is estimated on the basis of a set of sequential elements referring to the existence of quality controls throughout the production process, the use of quality control tools upon product on process, the use of specific forms at control points and the complexity of the control data and statistics they estimate (Questions 1 to 4 of Box 2). The following is a gradient based on the above elements:

4. High level of quality assurance. Firms use tools to perform quality control throughout the production process, they have control points at the line of production and keep control records. Control forms are used to estimate different statistics (histograms, cause and effect charts, statistic control of attributes, etc.).
3. Intermediate level of quality assurance. Firms use tools to perform quality control throughout the production process, they have control points at the line of production and keep control records. Control forms are used to estimate some of

the following statistics: histograms, cause and effect charts, statistic control of attributes, etc.

2. Low level of quality assurance. Firms use tools to perform quality control throughout the production process, but they do not use control forms at their control points, or do not have control points at all.

1. Lack of quality assurance. Firms do not perform quality control during the production process, or they do perform quality control during the production process but do not use measuring tools.

Additionally, there is a set of control questions which allows the verification of the level of reliability of answers[12].

The **degree of importance of engineers and technicians in the team** devoted to carry out developments –either formal or informal- is a qualifying factor both of the development team and of the complexity of the tasks it performs[13]. In that sense a classification of situations ranging from the lack of this type of qualification to those cases showing a significant proportion of engineers and technicians in the development team, was built:

5. High rate of professionals and technical personnel in the development team (more than 58%)
4. Medium rate of technical personnel (more than 29%)
3. Medium-low rate (more than 11%)
2. Low rate (more than 4%)
1. Very low rate (up to 4%)

In that sense, there is an estimation of the quotient between the number of engineers and technicians dedicated to quality and development activities in the total amount of employees in formal or informal teams devoted to such tasks in the firm.

The **scope of development activities** aims at estimating the number of areas carrying out developments, the amount of technical professionals and technicians (engineers, chemists, physicists, etc.) involved and the level of exclusivity of personnel devoted to developments. It is an indicator formed by the product of i) number of areas in the firm

[12] This quality assurance method proved more effective than the one based on direct questions to the firms about their use of productive performance indicators (rate of production waste, rate of rework time of final and in-process products in total production time, rate of final products discarded due to failure to meet minimum standards, average delivery times, stock rotation, evolution of in-process products and temporal productivity evolution) and of production organization techniques often affected by "fashion" (problem solving tools, control graphics, Pareto diagrams, statistics process control, quality circles, preventive maintenance, ISO 9000, Kanban, Just in Time, Analysis of failure mode and effect, cell production, etc.).

[13] In all cases, firms could identify an informal group –with different relative relevance- devoted to carry out developments and to problem solving. A characteristic of this group is that it was not focused on a specific department of the firm, but it was spread throughout the organization. This empiric verification coincide with what literature calls spread innovation processes (Lassini, 1992).

carrying out innovations[14], ii) rate of engineers and technicians in the total number of employees involved in development activities and a correction factor considering the degree of exclusivity of involved personnel[15].Thus the objective is to assign more relevance to firms in which the stable team involved with innovative activities tends to be exclusively dedicated to such tasks. When the product of the three factors (number of areas, rate of engineers and technicians in the development team and degree of exclusivity of such team) is 0, the indicator is equivalent to 1, which means development activities are almost non-existent. Conversely, when it is superior to 3, firms are considered to have a maximum range of innovative activities. Since part of this variable is the element "rate of engineers and technicians in the development team", the competencies of human resources involved in innovative activities have a weight superior to that explained here. As a control variable, the existence of records and tables of developed activities is estimated. The following are the absolute levels adopted by the indicator:

5. Maximum scope (product superior to 3)
4. Intermediate (between 1.5 and 3)
3. Low (between 0.4 and 1.5)
2. Minimum scope (less than 0.4)
1. Lack of innovative activities (product = 0)

ii) Factor estimating the innovative product

The weight of new products in the firm's total sales volume is an approximation to what literature calls innovative product (Meyer-Krahmer, 1984). This factor aims at estimating the impact of the introduction of products containing enhanced and/or new techniques upon the firm. In that sense, the participation, in the firm's total sales, of products introduced during a given period of time is estimated. In the case of Argentina, the weight of new products introduced by the firm from its opening on the billing of the last year is estimated. Consequently, each firm is classified in any of the following groups:

5. High participation (more than 75%)
4. Medium participation, between 50 and 75%
3. Low participation, between 25 and 50%
2. Minimum participation of new products, less than 25%
1. Non-existent

iii) Proxy factor for knowledge circulation

[14] The alternatives considered are: development (enhancement) of products and processes; organizational changes (internal JIT, Kan Ban, etc.), new types of relationships with the market and advancements towards quality assurance.

[15] When there is no personnel exclusively dedicated to innovative activities, the factor is equivalent to one fourth; and becomes a unit when all the employees are full-time. In intermediate cases the criterium applied is the following: one third, when the rate is inferior to 30%; half a point when the rate falls between 31% and 50%; two thirds, between 51% and 80%; and three fourth when the rate lies between 81% and 99%.

The **degree of technological cooperation** is a key element in the estimation of the IIC. It expresses the extent to which the "environmental" elements contributing to the circulation of codified and tacit knowledge foster the development of competencies and the innovative capacity of firms. Since a significant part of the knowledge required to carry out development activities has an important tacit component, its circulation and internalization on the part of the agents need the support of formal and informal relationships. The development of such relationships, which contribute to a change in routines, to the diffusion of informal knowledge and to the development of competencies, may be considered as an evolutionary process. Such process requires, as a starting point, the existence and/or development of mutual trust among agents which helps to this kind of diffusion. The indicator of technological cooperation is a proxy variable which aims at measuring the development level of interactions of local agents oriented towards the generation of technological, entrepreneurial and learning competencies.

The formal and informal relationships that firms maintain with other agents (firms, consulting companies, public and private institutions, universities, etc.) are proxy indicators of the environment behavior to: i) develop and enhance products and processes; ii) introduce organizational and management changes; iii) modify distribution channels; and iv) enhance and develop quality management. Thus, factors constituting the cooperation indicator would get different values in environments with different level of externalities generation. For example, there are negative environments where agents have few discontinuous interactions of scarce complexity and in which agents seeking joined activities do not develop informal relationships. On the other hand, there are positive environments characterized by the existence of a large number of complex interactions and by the development of informal cooperation relations which may arise dynamic processes of competencies. Between these two extreme positions, there is a wide range of alternatives focusing on the factors described later on in this section. Thus, the indicator of technological cooperation is the estimated average between the formal cooperation index (80%) and the informal cooperation index (20%).

The index of informal cooperation carried out by firms is the estimated average of the following variables[16]: *frequency of informal relationships* (30%); ii) *complexity of thematic areas* on which such relationships are kept (50%); iii) *number of agents involved in such informal relationships* (10%) and iv) *stability of informal relationships* (10%).

[16] The sequence of questions to evaluate the existence of informal cooperation was the following: firstly, it was stated that firms did maintain informal conversations with colleagues regarding different issues connected with the economic activity in general and with the performance of the firm in particular. If the answer was positive, the number of agents involved in the interaction, its frequency and stability was analyzed. Additionally, the existence of an institution coordinating such activities was checked and the thematic complexity of such relationships, analyzed. In that sense, the subjects of the conversations were: general situation of the country; situation of the province; internal channels of commercialization; difficulties of customs procedures; relationships with banks; financing possibilities; difficulties with work force; search for internal markets; issues/problems related to the entrepreneurial chamber; products enhancements; business within the MERCOSUR; search for international markets; international trade channels, rationalization of the productive process and the firm's organization/management; possibilities of developing joint ventures; problems related to quality management; search for partners to develop agreements. Finally, the effects of such conversations on the firm were analyzed.

As regards the *frequency of relationships,* when the informal contacts are on a daily basis, the value assigned is Level 4; when they are weekly, Level 3; Level 2 is assigned when they are monthly or every three months; and Level 1 indicates that the contacts are sporadic.

In order to evaluate the *level of complexity* of the issues on which firms develop their relations, 19 alternatives are considered. Among them there are simple and complex subjects. Therefore, the relative frequency of the 8 most complex alternatives are considered, namely: issues related to the entrepreneurial chamber; product enhancements, businesses within the Mercosur; search for foreign markets; external commercialization channels; possibility of developing joint ventures; problems related to quality management; and search for partners to reach cooperation agreements. If those alternatives are present in more than 70% of the answers, the firm was assigned a Level 4; Level 3 was assigned if the alternatives were present in 50% to 69% of the answers; Level 2 corresponds to 30% to 49% and Level 1 means less than 30% of the alternatives. As regards the number of agents, Level 4 is assigned to those cases in which this type of informal relation is held with many agents; Level 2 refers to some agents and Level 1 for 1 or 2 agents.

Finally, the stability of relationships is considered a dichotomy structure: Level 4 means regular conversations and Level 1, sporadic conversations.

From the viewpoint of **formal cooperation**, there is a series of objectives that causes the agents to associate (development and enhancement of products and processes, organizational changes, changes in their connection with the market, etc.) that is taken into account, together with their complexity (type of institutions and agents they relate to), the number of agents with whom they interact and the frequency of their interactions. Thus, the formal cooperation index results from the estimated average of the following variables: number of agents involved in the firms' interactions (35%); level of complexity of the interaction (30%); frequency of the interaction (25%) and links (10%).

The variable ***number of agents*** with whom the firm interacts considers a maximum of 21 alternatives. In that sense, firms are classified from 1 to 4 according to the following criteria: Level 4 implies more than 10 agents; Level 3, between 8 and 10 agents; Level 2, between 5 and 7 and Level 1, less than 5.

The variable ***complexity of the interaction*** considers the estimated average of the areas in which the firms interact, assigning less weight to those areas which seem less relevant from the point of view of innovation: i) enhancement and/or development of quality management (0.25%); ii) development of products and processes (0.25%); iii) organizational changes (0.20); iv) enhancements of products and processes (0.10); v) changes in distribution channels (0.06) and vii) exchange of information (0.06). Consequently, the factor acquires a Level 4 if the estimated average is more than 0.80; Level 3 when it falls between 0.50 and 0.80; Level 2, between 0.25 and 0.50 and Level 1 when it is less than 0.25.

The variable ***frequency of interaction*** considers the estimated average of links, assigning a different value to each frequency: daily interaction, 0.30%; weekly, 0.25%; monthly, 0.20%; quarterly or sporadic, 0.10%. In that sense, firms with an estimated average superior to 50% of the maximum value (7) belong to Level 4, those with an estimated average that falls between 40 and 49% are assigned a Level 3; between 26% and 39% is a Level 2 and less than 25% corresponds to a Level 1.

The variable ***links*** shows the level reached in the seven potential objectives sought by firms in their interaction with other agents: development and enhancement of products; organizational changes; new links with the market and quality enhancements. Thus, firms that have reached more than 3 links, are assigned a Level 4; when the number of links is 3, the Level assigned is 3; 2 links correspond to Level 2 and up to one link, to Level 1.

Since the trust intervals related to each factor value correspond to the different alternatives considered ex ante, their outcomes may be compared among the various panels used and with the panels used in other researches.

Each firm is assigned a level of innovative capacity equivalent to the estimated average of each of the six factors considered. This aggregated index has a variation scope that ranges between 1 (minimum value) and 4.5 (maximum value)[17]. Finally, in order to build a taxonomy of firms with different innovative capacity, five groups were built according to the extreme values of the distribution and an interval estimated as the difference between such values divided by five[18].

To summarize, each firm is given a value ranging from 1 to 5 for each of the factors considered, the result being a continuous variable. In order to distribute the studied firms by level of innovative capacity, five groups were defined, considering as class intervals the difference between the maximum and minimum value divided by five. This procedure has major impacts on the determination of estimated groups of innovative capacity. Thus, unlike exogenous determinations resulting from considering intervals set as a proportion of the distribution (i.e. 20% of the firms with the highest and lowest capacity), the proportions depend on the range of the differences between the firms with the highest and lowest innovative capacity. In that sense, the setting of categories does not depend on the form of the indicator distribution.

It is worth mentioning that the design of the indicators is based on the notion that the collected data is much more reliable when class intervals are analyzed instead of variables of a continuous type. Two reasons may account for that. On the one hand, in medium and small firms, management and ownership are, in general, intertwined in the figure of the owner. Therefore, the manager-owner handles a volume of information superior to that of large firms managers with a greater degree of function delegation.

[17] As shown in some cases, the variable acquires values between 1 and 4; therefore, the maximum possible value is less than 5.

[18] The innovation capacity indicator was divided into 5 groups. However, in the tables included in the next section, and with the purpose of analytic accuracy, level 5 is considered the level of maximum innovative capacity; levels 3 and 4, intermediate; and level 1 and 2 are considered of reduced innovative capacity.

Moreover, agents operate with limited rationality or less-than-perfect information and, therefore, their perceptions of the fundamental variables present in each of the six factors are not accurate.

2.1 Main hypotheses

The mentioned indicator of innovative capacity allows us to test some hypotheses commonly discussed in literature, using a set of auxiliary variables (Meyer-Krahmer 1984, Santarelli and Sterlacchini 1990, Lassini 1992, Malerba 1993, Acs and Audrescht 1995). Thus, some specific hypotheses are developed on the basis of the theoretical definitions mentioned in previous sections. These hypotheses will be contrasted against field work results and use of the innovative capacity indicator.

First hypothesis : The size of the firm (estimated according to its sales volume) and its market dynamism (estimated according to sales variation as from its opening) are characteristics positively associated to the development of the agents' innovative capacity.

Second hypothesis: In spite of the new economic scenario, competitive pressure increases both for those agents that direct their production to the domestic market and for those who trade part of their production to external markets. The latter group have less tariff barriers to protect their production; therefore, it is forced to introduce more innovative development than the former one. As a consequence, its innovative capacity is superior to that of the first group.

Third hypothesis: The level of development of the local system is crucial to explain the differences in the innovative capacity of agents. Thus, firms located in areas of greater development of local system have an average level of innovative capacity superior to those located in areas of lower development level.

Fourth hypothesis: The size of the firm is a variable which is positively associated to its innovative capacity development only in those environments where externalities are a minor element. This means that when the local system has a greater level of development, sales does not determine the firm's level of innovative capacity. However, it is worth noting that, even though local environment may in positive cases favor the development of the agents' innovative capacity, differences in their evolutionary path are important. Therefore, it is probable that even in the best areas there may be sharp differences in the agents' development of innovative capacities.

Fifth hypothesis: The dynamism of the firms is critical to determine their innovative capacity in environments with a greater degree of development and it is non significant in less developed local systems.

Sixth hypothesis: In a context where agents' strategic uncertainties increase, microeconomic differentiating factors are much more significant that sectoral ones.

3. Innovative capacity of agents and the role of environment

3.1 Sample of firms: first evidences

The sample of 245 firms used in this work is composed of sub-samples corresponding to four recent researches carried out on firms operating in different "environments": i) 119 firms belong to the municipality of Tres de Febrero -in the surroundings of Buenos Aires City-, an area that belongs to a larger urban conglomerate where the local factor and the innovative system go beyond the local context and where institutions do not foster links between firms and the innovative system (Moori-Koenig and Yoguel, 1998); ii) two areas of relatively greater environment development, Rafaela (Boscherini et al. 1998) and Mar del Plata (Alegre et al. 1997) where we find two out of three entrepreneurial development centers financed by the Inter American Development Bank in Argentina, and where 33 and 41 firms, respectively, were interviewed; and iii) a sample of 52 medium firms located in the Metropolitan Area with the common characteristic of exporting most of their production (Boscherini and Yoguel, 1996).

These firms, as a whole, have annual sales that amount to $ 1069 millions, with an average per firm of 4.3 millions. Even though most of the firms in the sample are characterized by their small (invoicing less than one million pesos per year) and medium size (between 1 and 7 millions), some larger firms have been included for the purpose of increasing the panel's heterogeneity[19]. Almost half the firms produces traditional products; 20%, goods that diffuse technical progress, and a relatively similar proportion (over 15%) agricultural and food products and motor vehicle parts. The exports of the firms in the panel are equivalent to 12% of their invoicing, which surpasses the average level of SMEs in Argentina. Half of these firms exports their products; their export levels differing according to the different local systems evaluated. Thus, while the firms in Tres de Febrero have a smaller export ratio (6.3%)[20], those from the export panel and those located in Rafaela have the largest relative level (16.8 and 12.5, respectively). There are, in turn, strong size differences among the analyzed areas, the firms of Tres de Febrero being the smallest and those of Mar del Plata and Rafaela, the largest[21].

At this stage, it is possible to state that there are strong differences in the innovative capacities of agents located in different local systems. Thus, while firms established in Rafaela and Mar del Plata excel the average of the panel in more than 25%, the export firms reach the average level and those located in Tres de Febrero show a level 12% lower than the panel average.

[19] 41.6% of the firms belongs to the first group, 42.9 to the second and 15.5% to the third.
[20] This level is relatively similar to the average level of SMEs in Argentina (Moori-Koenig and Yoguel 1995).
[21] Annual sales per firm amounts to 1.7 million pesos in the area of Tres de Febrero, 4.1 in the case of export firms, 7.2 for firms located in Mar del Plata and 10.6 for those in Rafaela.

Table 1. Background of the sample

Location	Number	Invoicing (millions of pesos)	Export ratios	Average innovative capacity
Tres de Febrero	119	1.7	6.3	88
Exportadores	52	4.1	16.8	99
Rafaela	33	10.6	125	127
Mar del Plata	41	7.2	s/d	126
Total	245	4.4	12.0	100

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

3.2 Innovative capacity of local agents: main differences among areas

The estimation of the indicator of innovative capacity for the 245 sample firms allows the identification of a small number of firms reaching the top level: only 2.5% of the total. Within that group, the ratio of firms located in the areas of greater relative development of the "environment" –Mar del Plata and Rafaela- (Rearte et al. 1997 and Boscherini et al. 1998) is significantly superior to those belonging to areas of relatively smaller development and to those of the Metropolitan Area. Thus, while 9.1% of the firms in Rafaela and 12.2% of those in Mar del Plata may be characterized as having a high innovative capacity, there are no firms in Tres de Febrero or in the export panel reaching such level (Table 2).

Moreover, 58.7% of the firms have limited innovative capacities. They assign minimum importance to quality assurance, the development of training processes, informal development teams and the presence of engineers and technicians, the development of new products and formal and informal technological cooperation with other agents. Also, the ratio of firms with limited innovative capacity is significantly larger in environments with a reduced relative development. Thus, while in Mar del Plata and Rafaela 39% and 36% of the firms, respectively, belong to this group, in Tres de Febrero and in the set of medium export firms, the ratio of firms is significantly superior: 71% and 60% of the total firms respectively. That means that the weight of firms with less (more) innovative capacity in Mar del Plata and Rafaela is significantly lower (superior) than their share in the sample, these proportions are exactly the opposite for the firms in Tres de Febrero and, to a lesser extent, in the sample of export firms located in Great Buenos Aires (Table 2).

This reduced ratio of firms with endogenous capacities does not result from the type of indicator used. A recent research aiming at evaluating the technological behavior of firms starting from the opening up of the economic reaches similar conclusions using other indicators for a panel of 1531 firms (Rabetino and Yoguel, 1999)[22]. On the one hand, the

[22] This indicator includes 11 quantitative, qualitative and quasi-quantitative factors –considered crucial for the development of competencies on the part of firms. The quantitative factors considered are: i) ratio of employees devoted to R&D activities and a set of ratios related to the sales of the firms; ii) consulting costs; iii) costs of development activities; iv) license acquisitions; v) expenditures on capital goods used on

small number of agents which are close to the state of the art and international technical boundaries stands out clearly . On the other hand, 64% of Argentine industrial firms may be characterized as having a reduced technological capacity; in the case of SMEs, such ratio involves 82% of the agents. Therefore, regarding SMEs, the above results are much more serious than the ones drawn from the sample used in this research[23].

It is worth noting that even in environments in which the creation of externalities is more significant, the ratio of firms with low innovative capacity is very high, showing the relevance of considering the heterogeneity of the behavior of the agents under analysis. The above reinforces the notion that, in order to take advantage of externalities generated by the local system in which they operate, some minimum thresholds of competencies are required. *Furthermore, in a very preliminary way, these data support the second hypothesis –to be analyzed in detail in the following section- which states that the innovative capacity of agents depends positively on the level of development of the local environment*.

Table 2. Firms distribution by level of innovative capacity and environment development

Innovative capacity a/	Mar del Plata	Rafaela	Export Firms	Tres de Febrero	Total
High	12.2	9.1	0.0	0.0	3.3
Medium	48.8	54.5	40.4	28.6	38.0
Low	39.0	36.4	59.6	17.4	58.7
Total	100.0	100.0	100.0	100.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

Notes: a/ the group of high innovative capacity includes those agents characterized with Level 5 in the construction of the indicator; the medium group corresponds to Level 3 and 4; and the group of low innovative capacity corresponds to Level 1 and 2, the lowest level in the indicator.

Table 3. Distribution of firms by level of innovative capacity and environment development

Innovative capacity a/	Mar del Plata	Rafaela	Export Firms	Tres de Febrero	Total
High	62.5	37.5	0.0	0.0	100.0
Medium	21.5	19.4	22.6	36.5	100.0
Low	11.1	8.3	21.5	59.1	100.0
Total	16.7	13.5	21.2	48.6	100.0

product and processes innovation. The qualitative factors, which are turned into quantitative variables, are: i) level of formality of development activities; ii) industrial organization techniques used; iii) importance assigned to products and processes enhancement; iv) use of information technology in relation to suppliers and customers and; v) importance of tacit and codified source of information. Finally, the training index was estimated as quali-quantitative factor. Each of these factors were assigned a value ranging from 1 (minimum level) to 5 (maximum level). The estimation of these factors is a combination of the firm's fixed weight within the group where it belongs and changes in the weight of each of the qualitative, quantitative or quali-quantitative aggregates. In order to evaluate the impact of change in the firms' ranking by technological capacity, 5 indicators were estimated, ranging from those of less relative weight of qualitative variables to those in which such variables are predominant. The results do not modify the ranking of the firms.

[23] This may be due to: i) the panel of 1531 firms compares the technological behavior indicator of SMEs against that of larger firms and ii) the average size of SMEs of the above panel is smaller than that of the panel presented here.

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).
Notes: a/ the group of high innovative capacity includes those agents characterized with Level 5 in the construction of the indicator; the medium group corresponds to Level 3 and 4; and the group of low innovative capacity corresponds to Level 1 and 2, the lowest level in the indicator.

Therefore, while firms located in Rafaela and Mar del Plata reach, in average, an innovative capacity level of 60% of the maximum possible level (Table 4), export firms and those located in Tres de Febrero have a level of 50% and 46%, respectively, of the theoretical maximum. However, the relatively higher levels of Rafaela and Mar del Plata do not show similarly in each of the six factors included in the innovative capacity index, implying significant differences between both areas.

Table 4. Level reached by each of the six factors included in the innovative capacity index in relation to the maximum theoretical level and according to the firm's location

	Total	Training	Quality	Weight of engineers	Scope	New Products	Technological cooperation
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rafaela	60.3	55.7	63.7	47.7	54.2	56.8	78.0
Mar del Plata	59.1	71.3	51.8	76.6	60.0	52.7	46.3
Export firms	50.2	54.3	55.3	49.6	40.4	37.7	58.1
Tres de Febrero	45.6	46.0	44.7	55.8	44.9	42.1	44.1

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

Nevertheless, it is worth noting that within these "environments" there is a marked heterogeneity of situations, and that point becomes crucial to understand the limited importance of externalities in Argentina to explain differences in the innovative capacity of agents. Firstly, at least 45% of the total firms of the panel belongs to the smallest group in each of the six factors composing the innovative capacity index. However, among the firms established in Rafaela, those factors involving the largest proportion of cases in the lowest levels are: *the weight of engineers in development teams, the scope of development activities and the impact of new products on sales volume and training efforts*. That means that although firms located in Rafaela and Mar del Plata, in average, show the highest indexes of innovative capacity, in four out of six factors the ratio of firms with reduced levels is very high.

For example, firms in Rafaela stand out of the rest due to their level of quality assurance, new product development and, specially, to their level of technological cooperation which constitutes a distinctive characteristic of that area (Ascua et al 1989, Boscherini et al, 1998). The great concern of Rafaela's firms regarding quality assurance shows in that at least 58% of them carries out quality control processes with tools along the production process, provides check points and maintains control records with which they elaborate statistics such as histograms, cause and effect charts and attribute statistic control, among others. In this framework of high ratio of firms carrying out cooperation processes[24], the formal cooperation factor is significantly more relevant than the one considering informal

[24] 58% of the firms in Rafaela may be characterized by their high or medium level of technological cooperation.

cooperation among agents. Thus, a significant proportion of Rafaela's firms maintains daily and weekly informal communications with other agents (79% of total cases), on subjects of high and medium complexity (68%), with certain regularity and with up to 5 agents (62%). However, the ratio of agents of high and medium innovative capacity is significantly inferior. In spite of the importance of informal cooperation, this indicator is related neither to their innovative capacity, nor to any of the 6 factors determining it. Nevertheless, from a dynamic point of view, such elements may turn into key factors for the diffusion of tacit local knowledge and the development of the local innovation system. Conversely, the fact that the informal cooperation factor is not very important may be showing that, even in areas where the environment is relatively more developed, such environment is still very distant from the advanced clusters and local systems where informal relationships among agents are crucial (i.e. Silicon Valley)[25]. Regarding the importance of product development, it is worth noting that this process occurs in a framework in which traditional products are clearly predominant, and goods spreading technical progress and those related to the motor vehicle sector acquire less significance. This is an aspect shared by the quasi-district and some Italian clusters which reach a high competitive position manufacturing traditional goods such as ceramics, footwear and textiles. In that sense, the case of Rafaela shows the role of innovative entrepreneurs in activities which ex ante may be classified as mature.

Regarding the firms of Mar del Plata, the differentiating factors for the innovative capacity of agents are their training efforts, the ratio of engineers in development teams and the scope of development activities[26]. Conversely, elements which appear as differentiating aspects in the case of Rafaela, specially technological cooperation, acquire a significantly inferior importance, similar to that corresponding to Tres de Febrero in which the local system has a lower relative development[27]. The high levels of the three

[25] The high level of informal cooperation found in agents from Rafaela differs from the reduced level of such cooperation showed by 600 SMEs located in different geographical areas in Argentina, recently studied in a research on environment restrictions (Angelelli et al. 1999). In this last case, almost 60% of the agents showed –using the same indicator- a high level of relative isolation, mostly independent from their localization, size, activity sector and their age in market. Furthermore, the reduced development of local contexts showed in the fact that firms with more links with other agents were not the ones with the greatest relative dynamism. The limited importance of environment and firms interaction as elements contributing to the development of agents' capacities showed in the fact that the dynamism from the opening of "isolated" firms was, on average, superior to those with more relationships. Finally, the isolation of agents was strongly related to the level of isolation firms had regarding institutions: i.e. agents with a smaller index of informal cooperation are characterized by their fewer links with institutions within their environment. Again, this situation differs from the case of Rafaela where both the informal cooperation and the relationship between firms and institutions is very significant (Boscherini et al. 1998).

[26] The case study carried out in Mar del Plata (Alegre et al., 1998) reveals that high levels of factors such as training and participation of engineers and technicians might be related to the high level of university students from Engineering –approximately 120 graduates per year- and technical schools –around 300 graduates per year- leading to the high level of qualification of local labor supply". In that sense, even though development teams in each firm are reduced, the strong presence of engineers adds to the development of training courses carried out by agents.

[27] This is also supported by data from the mentioned survey on environment restrictions to Argentine SMEs (Angelelli et al., 1999). In the case of Mar del Plata, 76% of the firms have a high degree of relative isolation, very similar to firms located in Bahía Blanca and superior both to the panel's average (58%) and to the agents located in the Metropolitan Area.

factors mentioned together with the limited technological cooperation show that innovation processes are supported, basically, by agents' individual efforts. However, in spite of the scarce cooperation among agents, there is a significant action on the part of local institutions contributing to the development of competencies of local firms.

In that sense, in the last years there have appeared various educational, technological, and entrepreneurial institutions, that foster and assist productive activities; and there have been changes in most existing policies. Therefore, it is possible for local firms to think about an institutional environment which will be able to promote and facilitate competitive growth on the basis of the development of innovative processes (Alegre et al. 1997). In addition to a University with a great number of researchers working on applied scientific and technological research, there are educational institutions with technical orientation and linking and fostering institutions which act as "facilitators" of the local productive sector. Furthermore, for the small number of firms that carry out entrepreneurial cooperation activities, such relationships had a medium/high impact on the development of their innovative activities.

On the other hand, the export panel and the firms located in Tres de Febrero are characterized by their great ratio of firms with low innovative capacity. In the former group, the fragile existing association between the agent's innovative capacity and the export ratio becomes evident, arising some doubts as regards the future evolution of SMEs exports (Boscherini and Yoguel, 1996). This could be explained by two phenomena aiming at the same direction. On the one hand, among firms with low innovative capacity there are cases of high –generally countercyclical- internationalization. On the other hand, there is a group of firms of high innovative capacity[28] among those with lower export ratio.

Most firms in the export panel have a partial vision about the complexity of the innovative process. In that sense, they do not perceive the development of competencies and the dynamic learning processes to be necessary conditions to reach innovative capacities, allowing general knowledge to become specific and tacit. This shows, for example, in the levels of factors such as "training" and "quality" which amount to half the theoretical maximum and, in the case of the "scope of development activities" factor, to only 40% of the theoretical maximum. The specific study case also shows that firms do not seem to appreciate and understand the importance of a favorable environment fostering innovative activities and reducing their risk, and favoring the systemic interaction with other economic agents. In that sense, the technological cooperation factor, while superior to that corresponding to firms located in Mar del Plata and Tres de Febrero, is remarkably lower to the one corresponding to Rafaela. Unlike the case of Rafaela, firms with higher innovative capacity are not those manufacturing traditional goods (textiles) but those that diffuse technical progress (chemical and metal mechanical firms in the sector of design and manufacturing of high technology machines and equipment) and, at a lesser extent, the commodities.

[28] In this case, the development of competencies acquired in the last years has not been followed by an increase in international insertion.

In the case of firms located in Tres de Febrero, the lowest values correspond to "training efforts", "quality assurance" and "technological cooperation" factors. In the first case, 60% of the firms had less than 5% of their human resources involved in quality management and development courses. Additionally, a similar ratio of firms either do not perform quality controls or do not use measuring tools for controlling processing products. As regards the technological cooperation factor, the firms located at Tres de Febrero show a higher degree of isolation if compared with other firms and institutions. The situation gets worse if we take into consideration only the technological cooperation of such firms with universities, service centers, consulting firms and technological institutions; almost 80% of the firms lacks interaction with those agents. This may also reflect the limited impact of the wide range of technological support services existing in the Metropolitan Area, specially taking into account that, in the city of Caseros (most important city in the district, located at a distance of less than 10 miles from the Capital City), there are key elements of the national technological system and institutions related to the formation of competencies (Moori Koenig and Yoguel 1998)[29].

3.3. The size of agents: an element conditioning innovative capacity

Besides the different degree of development of the environment, the size of the agent seems to play an important role in the development of agents' innovative capacity. Thus, for example, firms invoicing more than $ 18 millions per year represent only 5.3% of the total panel, accounting for 37.5% of the group of high innovative capacity and only 1.4% of firms with low innovative capacity (Table 5). On the other hand, firms invoicing less than $ 1 million per year, representing 41% of the total, account for 55% of the group of reduced innovative capacity and only 12.5% of the higher group. In turn, firms with invoicing ranging between the two extreme groups, have a very high representation among firms with medium innovative capacity, a participation similar to their weight over high innovative capacity firms (Table 4). These results coincide with the first working hypothesis; innovative capacity is associated to the size of the agent.

Table 5. Distribution of agents in the panel according to innovative capacity as per annual invoicing

Annual invoicing (mill. of pesos)	High Innovative Capacity	Medium Innovative Capacity	Low Innovative Capacity	Total
More than 18	37.5	8.6	1.4	5.3
Between 7 and 18	25.0	18.3	4.2	10.2
Between 3 and 7	0.0	25.8	13.2	17.6
Between 1 and 3	25.0	24.7	25.7	25.3
Between 0.4 and 1	0.0	12.9	36.1	26.1
Less than 0.4	12.5	9.7	19.4	15.5
Total	100.0	100.0	100.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

[29] Centro Tecnológico Migueletes of the Instituto de Tecnología Industrial (INTI), Comisión Nacional de Energía Atómica (CNEA), Instituto Nacional de Tecnología Agropecuaria (INTA), institutes for professional formation, National Technological University (Haedo and Pacheco), four national universities and one private university.

However, within each of the size groups considered, there is a marked heterogeneity of innovative capacities. This shows that the association between both variables is affected by other factors. Thus, even though among larger firms there is a predominance of firms with higher innovative capacity, there are also larger firms located in medium and low innovative capacity groups; almost 66% and 15%, respectively. In turn, even though more than 70% of the agents with annual invoicing inferior to $1 million belong to the low innovative capacity group, almost one fifth belong to the medium innovative capacity one (Table 6).

Table 6. Distribution of agents in the panel by size according to innovative capacity

Annual invoicing (mill. of pesos)	High Innovative Capacity	Medium Innovative Capacity	Low Innovative Capacity	Total
More than 18	23.1	61.5	15.4	100.0
Between 7 and 18	8.0	68.0	24.0	100.0
Between 3 and 7	0.0	55.8	44.2	100.0
Between 1 and 3	3.2	37.1	59.7	100.0
Between 0.4 and 1	0.0	18.8	81.3	100.0
Less than 0.4	2.6	23.7	73.7	100.0
Total	3.3	38.0	58.8	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini, et al (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

It is worth noting that the existing relationship between size and innovative capacity does not show equally in the six factors which determine it. Thus, for example, among the larger firms in the panel the factors with greater ratio of agents at higher levels are: training and quality assurance efforts. Conversely, in the case of factors estimating the weight of new products in the invoicing, the scope of development activities and the degree of technological cooperation, most firms correspond to the lower level.

In the case of firms with lower annual invoicing, most agents are concentrated in the lowest levels of each factor. On the other hand, the higher ratio of firms belonging to the higher categories corresponds to the “weight of engineers in the development team” and “training” factors.

3.4 Innovative capacity of agents, international insertion, market dynamism and the characteristic of elaborated products

Almost 37% of the firms in the panel had a positive performance since the convertibility program was launched; which showed in a sales increase that extended not only over the expansive stage of the plan (1991-1994) but over the period including the Mexican crisis. Conversely, almost 34% of the firms experimented a drop of sales during that period. *In that context, the performance of firms with higher innovative capacity is clearly superior to those belonging to the opposite category*. This shows in the fact that all of the firms with high innovative capacity recorded increases in both stages of the convertibility plan and only 25% of the firms with low innovative capacity had a positive dynamic. Furthermore, while there are no firms with high innovative capacity recording sales drops, the ratio reaches 45% in the case of firms with low innovative capacity (Table 7).

Table 7. Distribution of sample firms by innovative capacity according to their degree of dynamism as from the economic opening process

Innovative capacity	1 a/	2 b/	3 c/	4 d/	Total
High	100	0.0	0.0	0.0	100.0
Medium	48.9	33.3	8.9	8.9	100.0
Low	25.7	28.5	19.4	26.4	100.0
Total	36.8	29.3	14.9	19.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).
Notes: a/ firms increased their production level both in the growth stage of the Convertibility Plan and in its crisis stage (1995-1996); b/ they increased their production level only during the growth stage; c/ they increased their production level during the crisis stage; d/ they diminished their production level in both periods.

This situation may be clearly observed when estimating the ratio of firms with different level of dynamism belonging to the three groups of innovative capacity (Table 8). Thus, 83% of the firms that showed the most negative performances belong to the low innovative capacity group and almost half the firms of better dynamism, belong to medium and high innovative capacity groups. Finally, 58% of the firms recording a procyclical behavior may be classified as belonging to the low innovative capacity group.

Table 8. Distribution of sample firms by innovative capacity according to their degree of dynamism as from the economic opening process

Innovative capacity	1 a/	2 b/	3 c/	4 d/	Total
High	9.0	0.0	0.0	0.0	2.5
Medium	41.4	42.3	22.2	17.4	37.9
Low	41.6	57.7	77.8	82.6	61.7
Total	100.0	100.0	100.0	100.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).
Notes: a/ firms increased their production level both in the growth stage of the Convertibility Plan and in its crisis stage (1995-1996); b/ they increased their production level only during the growth stage; c/ they increased their production level during the crisis stage; d/ they diminished their production level in both periods.

The degree of innovative capacity reached by firms is closely related to the level of international insertion reached. Thus, while 71% of the agents who either do not export or export in a quantum inferior to 4% of their sales are considered to have low innovative capacity, 44% of those firms recording exports superior to that level belong to that group. On the other hand, almost 56% of the “export” firms reach a medium and high innovative capacity level, while less than 30% of firms with limited or no export capacity reach that level (Table 9).

Table 9. Distribution of sample agents by international insertion according to their innovative capacity

Export ratio	High innovative capacity	Medium innovative capacity	Low innovative capacity	Total
Null or less than 4%	0.7	28.7	70.6	100.0
Superior to 4%	6.4	49.5	44.1	100.0
Total	3.3	38.0	58.8	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

This shows also in the fact that the weight of firms with very low export capacity in the group of firms with high innovative capacity is significantly lower than the one they have in the total panel (Table 10).

Table 10. Distribution of sample agents by international insertion according to their innovative capacity

Export ratio	High innovative capacity	Medium innovative capacity	Low innovative capacity	Total
Null or less than 4%	12.5	41.9	66.7	55.5
Superior to 4%	87.5	58.1	33.3	44.5
Total	100.0	100.0	100.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

Finally, it should be noted that the type of final product does not seem to be decisive when estimating the innovative capacity of the analyzed agents (Table 11).

Table 11. Distribution of panel firms by type of product according to their level of innovative capacity

Product	High innovative capacity	Medium innovative capacity	Low innovative capacity	Total
Agricultural foods	5.3	39.5	55.3	100.0
Traditional	1.7	33.9	64.4	100.0
Motor vehicle parts	2.5	42.5	55.0	100.0
Technical progress diffusers	6.1	42.9	51.0	100.0
Total	3.3	38.0	58.7	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

That means, the manufacturers of food and products for the diffusion of technical progress are over-represented in the high innovative capacity group, while those manufacturing Motor vehicle parts and, specially, traditional goods are under-represented (Table 12.)

Table 12. Distribution of panel firms by level of innovative capacity according to type of product

Product	High innovative capacity	Medium innovative capacity	Low innovative capacity	Total
Agrofoods	25.0	16.1	14.6	15.5
Traditional	25.0	43.0	52.8	48.2
Motor vehicle parts	12.5	18.3	15.3	16.3
Technical progress diffusers	37.5	22.6	17.4	20.0
Total	100.0	100.0	100.0	100.0

Source: Author's work based on Alegre et al. (1997), Boscherini et al. (1997), Moori-Koenig and Yoguel (1997) and Boscherini and Yoguel (1996).

4. The size of agents and the role of environment as decisive factors for the differentiating process of firms' innovative capacity: test of hypotheses and econometric evidences[30]

In this section there is a series of models allowing the testing of the hypotheses presented and evaluated in the previous section . Thus, the elements evaluated are: i) the existing relationship among dynamism, size of the agents and firms' innovative capacity; ii) the degree of association existing between the firms' innovative capacity and their international insertion; and iii) whether such relationship is affected by the environment. In that sense, in order to analyze the mentioned hypotheses, four models relating the agents' innovative capacity with a series of "instrumental" and "censored" variables are presented.

In order to analyze the first hypothesis, the relationship between the agents' innovative capacity and the size and dynamism of the market as from the trade openness process was considered.

$$ICIi = C + a\ SIZEi + DYNAMISMi + ui$$

Where:
ICI is the index of innovative capacity of firms
SIZE is the annual invoicing of firms
DYNAMISM is the dynamism of firms

As presented in Box 1 of the Statistical Annex, both invoicing and dynamism are relevant variables –5% of confidence- and they are positively associated with the innovative capacity of firms. That means, the agents in the sample with the highest innovative capacity are the larger ones and those showing greatest dynamism from the start of the trade openness process. Therefore, such results confirm the first hypothesis.

For the purpose of analyzing the second hypothesis, the panel was divided into two groups; i) firms recording exports for an amount which surpasses 4% of total sales and ii) firms that either do not export or have lower export ratios. In that sense, an instrumental variable was onsidered, assigning value 1 to the former group and 0 to the latter.

[30] This section is based on Yoguel and Kweitel, 1998.

$$ICIIi = C + a\ DUMMY\ Xi + ui$$

Where:
ICI is the index of innovative capacity of firms
DUMMYX has a value of 1 for firms with an export ratio superior to 4% and 0 for the rest.

The results (Box 2, Statistical Annex) allows the consideration that the independent variable used is positively associated to the agents' innovative capacity. That means firms with a higher level of international insertion have a higher level of innovative capacity.

As regards the third hypothesis, four "instrumental" variables representing each of the four environments studied, the agent's size and its dynamism during the 1990s, were used. The following model was presented:

$$ICI = a1L1i + a2l2i + a3L3i + 4L4 + a\ 5Sizei + a6Dinamismi + ui$$

Where (Box 2)
L1 equals 1 if the firm is located in Mar del Plata and 0 if it is not.
L2 equals 1 if the firm is located in Rafaela and 0 if it is not
L3 equals 1 if the firm belongs to the group of export firms and 0 if it does not
L4 equals 1 if the firm is located in Rafaela and 0 if it is not

As shown in Box 3, the four locations proved relevant to 1% of confidence for the determination of the index. However, in the second model it became clear that, after checking by the variable "location", the variable "invoicing" lost relevance. This shows that the "environment" in which firms operate is a significant factor in the determination of the agents' innovative capacity.

In order to further analyze this phenomenon and, specially, to estimate the impact of size and dynamism of the agents, a model with censored variables in each of the environments, for the "size" and "dynamism" variables, was used.

$$ICI = a1L1i + a2l2i + a3L3i + 4L4 + a\ 5Sizei + a6Dinamismi + a7FL1 + a8FL12 + a9FL13 + a10FL14 + a11DL1 + a12DL2 + a13DL3 + a14DL4 + ui$$

Where:
FL1: has the invoicing data if the firm is located in Mar del Plata and 0 if the firm is located in another environment
FL2: has the invoicing data if the firm is located in Rafaela and 0 if the firm is located in another environment
FL3: has the invoicing data if the firm belongs to the group of export firms and 0 if it does not
FL4: has the invoicing data if the firm is located in Tres de Febrero and 0 if the firm is located in another environment
DL1: has the dynamism data if the firm is located in Mar del Plata and 0 if the firm is located in another environment

DL2: has the dynamism data if the firm is located in Rafaela and 0 if the firm is located in another environment
DL3: has the dynamism data if the firm belongs to the group of export firma and 0 if it does not.
DL4: has the dynamism data if the firm is located in Tres de Febrero and 0 if the firm is located in another environment

The regression shows that the "invoicing" variable is not relevant in Mar del Plata, Rafaela, or in the export group to explain the innovative capacity of agents. Conversely, it represents a significant variable for those firms located at Tres de Febrero. *These results confirm the third hypothesis. In the studied environments, with positive externalities, size does not constitute a differentiating variable of the agents' innovative capacity*. The above model confirms also the fourth hypothesis, since the "dynamism" variable became significant in the case of those environments with greater institutional complexity and more relationships among agents (Mar del Plata and Rafaela). On the other hand, it is not statistically relevant in the area of lower relative development of the environment (Tres de Febrero).

This model may be stylized applying the Wald test which allows the reduction of the number of censored variables and instrumental variables used, and the classification of variables that do not present differences in their ratios. In the model presented in Box 5 (Statistical Annex), innovative capacity is related to: i) a censored variable considering invoicing only for Rafaela, Mar del Plata and the export firms panel and equals to 0 in the remaining cases; ii) a censored variable considering invoicing only for the firms located at Tres de Febrero and is assigned a 0 value in the rest of the cases; iii) an instrumental variable adopting value 1 for firms located in Rafaela or Mar del Plata and 0 for other cases; iv) an instrumental variable adopting value 1 if firms belong to the export panel and 0 for the other cases; v) a censored variable adopting the dynamism value if the firm is located at Rafaela, Mar del Plata or belong to the export panel and 0 if it is located at Tres de Febrero; and vi) a censored variable that adopts the dynamism value if the firm is located at Tres de Febrero and 0 in all the other cases.

This model confirms the same conclusions previously drawn as regards the invoicing and dynamism variables classified by environment. In turn, after controlling by invoicing and dynamism in each environment, the results obtained from the model confirms that location is still relevant. Firms located in Mar del Plata are not very different to those located in Rafaela. This is a very interesting result because it shows that the "environment" variable allows the differentiation of dichotomy behaviors but assimilates areas having a relative similar amount of externalities generation. These results are also affected by the existence of a strong intra-environmental heterogeneity. That means that, even if the innovative capacity of firms in Rafaela and Mar del Plata is significantly superior to that corresponding to firms located in Tres de Febrero, in the areas of greater relative development, the variability of the agents' innovative capacity is high. Thus, *it may be concluded that the evolutionary path and microeconomic differentiating factors are relevant and act jointly with factors determining the type of externalities (positive or negative) generated in local systems*.

Lastly, the importance of the sector as determinant of the level reached by the agents' innovative capacity is estimated when it is considered together with the size of agents and their level of international insertion (Box 6, Statistical Annex). Thus, the model confirms the sixth hypothesis; the sector does not seem to be a relevant variable to estimate the differences of the firms' innovative capacities.

To summarize, one of the most relevant results obtained is that the size of the firms is positively associated to the agents' innovative capacity only if the agents are located in the area of Tres de Febrero. Conversely, in the case of firms located in Rafaela, Mar del Plata or the export panel, size does not have any association with the level of innovative capacity reached. In turn, from the point of view of the degree of environment development, the models presented reveal that, their belonging to the areas of Mar del Plata, Rafaela and, to a lesser extent, to the export panel, does imply an important difference for the firms regarding innovative capacity when compared to those located in Tres de Febrero, if the other factors are not taken into account. Lastly, the firms' dynamism as from the trade openness process would only be associated to the level of innovative capacity of agents if they are located in Rafaela, Mar del Plata or belong to the export panel.

Conclusions

The analysis of the firms' sample confirmed the existence of a positive association between the development of the agents' innovative capacity and their size. Additionally, the estimated models show that in positive environments (i.e. Rafaela, Mar del Plata) both variables are not related and there are minor differences in the competence development of agents of different sizes. That means that in those local systems, positive externalities counteract competitive advantages related to size. Conversely, in those environments characterized as negative, the agents' size plays a key differentiating role as regards agents' behavior.

However, the existence of positive environments does not invalidate the evolutionary differences of agents. Thus, even if in average the innovative capacity index of positive environments is superior to the one corresponding to negative environments, there are microeconomic factors that account for the differences in the innovative capacity of agents belonging to the same environment. These results are consistent with the evolutionary approach adopted –according to which agents are expected to behave differently over time when facing exogenous shocks- Thus, in order to take advantage of externalities generated by a "local" environment, certain minimum competencies are required, without which it is impossible to supplement missing knowledge, reduce dynamic uncertainties, strengthen learning processes and counteract the weaknesses of the organizational culture. However, this "minimum" threshold increases in the case of environments where negative externalities are predominant. In negative environments, microeconomic factors are likely to prevail over the development of external economies in the agents' differentiating process. For the agents operating in such environments, location does not play any role in the development of their competitive advantages.

Furthermore, the absence of "agents" linking firms and scientific-technological institutions increases the minimum threshold required for the agents to have access to the technological services supply. In turn, such absence becomes a restriction for firms to express their demand in the market and to develop an appropriate supply to meet the needs of local agents. That means, the absence of the above agents limits the construction of the market.

Now, even if –on average- the innovative capacities of firms located in "positive environments" are greater than those developed in negative ones, there are strong differences within them due to the different microeconomic paths of the agents. Therefore, microeconomic differences among agents are even more relevant than the environmental factors.

Specially, in negative environments, the presence of firms clusters becomes decisive and may imply a lower development of the local system (Moori-Koenig and Yoguel 1998b). In general, these clusters show differences within the local systems due – among other reasons- to their degree of quality assurance, their training efforts, the scope of their development activities, the ratio of engineers and technicians in development teams, new products development and their level of formal and informal technological cooperation.

In that sense, this research has put forth that, in environments where positive externalities prevail, institutional development seems to be an important determinant regarding the innovative capacity level reached by agents. In those environments, the evolutionary path of institutions becomes a basic element in the generation of public space promoting those factors that allow the endogenous development of a region. In the case of firms located in Rafaela and Mar del Plata, the institutional development has brought about the creation of two out of the three centers for entrepreneurial development that the Inter American Development Bank has established in Argentina. In these areas, the transmission of knowledge –either coded or tacit- through informal cooperation practices among agents and institutions, contributes to the build-up of competencies. Due to externalities generated in those areas, the minimum level of competencies required to have access to technological services is lower; therefore, the usage of services is more common, regardless of the innovative capacity of the agents.

Furthermore, in those "environments", the ratio of firms with high innovative capacity is significantly superior to the panel's average; minor relative differences can be found among agents belonging to the extreme levels. In that case, the factors which are crucial in differentiating innovative capacity levels are: technological cooperation; quality assurance and training efforts. In the specific case of technological cooperation, the values are high even for agents with medium and low innovative capacity. In that case, formal -and specially, informal- technological cooperation may become the equilibrium factor for missing competencies, facilitating the transmission of codified and tacit knowledge and the development of mutual confidence between agents.

In the "environments" hereby considered as the most negative (Tres de Febrero and the export SMEs located in the Metropolitan Area), the microeconomic factors tend to

prevail over the environmental ones in the development of the agents' competencies. In those areas there is a very reduced ratio of firms with high innovative capacity which distinctive characteristics are their larger size and market dynamism and their profiting from entrepreneurial cooperation agreements and SMEs-oriented technological support programs supplied by local institutions. Contrary to those areas with positive externalities, their lower institutional development increases the minimum thresholds necessary to have access to the technological service supply. In turn, technological – formal or informal- cooperation has limited importance.

Thus, in negative environments, the size of firms becomes a decisive factor to understand differences in performance and innovative capacity development. In that sense, since in more favorable environments size does not constitute a variable differentiating behaviors, the existence of any association between the size of the agent and the development of its innovative capacity may be considered a proxy variable for the local environment development.

Statistical annex

In this statistical apendix we ilustrate the details of the econometric models used to check the hypotesis developed in the paper. The symbols used have the same meaning that had been used in the text:

Box N. 1

Association among Innovation Capacity with size and dinamism of the firms

LS // Dependent Variable is INNOVA2
Sample: 1 245
Included observations: 245
Excluded observations: 0 after adjusting endpoints

Variable	Coefficient	Std. Error	T-Statistic	Prob.
SIZE	1.19E-08	4.09E-09	2.904544	0.0040
DINAMISM	0.325858	0.053055	6.141862	0.0000
C	1.540367	0.113078	13.62214	0.0000

R-squared	0.192636	Mean dependent var	2.250409
Adjusted R-squared	0.185964	S.D. dependent var	0.751537
S.E. of regression	0.678066	Akaike info criterion	-0.764851
Sum squared resid	111.2653	Schwartz criterion	-0.721978
Log likelihood	-250.9457	F-statistic	28.87047
Durbin-Watson stat	2.032806	Prob(F-statistic)	0.000000

Box N. 2

Asociation between Innovation Capacity and international insertion of firms

LS // Dependent Variable is INNOVA2
Sample: 1 245
Included observations: 244
Excluded observations: 1 after adjusting endpoints

Variable	Coefficient	Std. Error	T-Statistic	Prob.
DUMMYX	0.572554	0.089328	6.409544	0.0000
C	1.953059	0.064192	30.42535	0.0000

R-squared	0.145125	Mean dependent var	2.248723
Adjusted R-squared	0.141592	S.D. dependent var	0.752617
S.E. of regression	0.697302	Akaike info criterion	-0.712911
Sum squared resid	117.6676	Schwartz criterion	-0.684246
Log likelihood	-257.2459	F-statistic	41.08226
Durbin-Watson stat	1.830110	Prob(F-statistic)	0.000000

Box N. 3

Asociation among Innovative Capacity, localization, size and dinamism

LS // Dependent Variable is INNOVA2
Sample: 1 245
Included observations: 245
Excluded observations: 0 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
L1	1.980608	0.166348	11.90640	0.0000
L2	1.915290	0.165991	11.53853	0.0000
L3	1.616014	0.127061	12.71843	0.0000
L4	1.547011	0.101184	15.28911	0.0000
SIZE	8.73E-09	5.55E-09	1.571750	0.1173
DINAMISM	0.261614	0.052031	5.028048	0.0000

R-squared	0.240765	Mean dependent var	0.250409
Adjusted R-squared	0.224882	S.D. dependent var	0.751537
S.E. of regression	0.661659	Akaike info criterion	-0.801824
Sum squared resid	104.6325	Schwartz criterion	-0.716079
Log likelihood	-243.4165	F-statistic	15.15812
Durbin-Watson stat	2.142444	Prob(F-statistic)	0.000000

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Danish Research Unit for Industrial Dynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes:

- The firm as a learning organisation
- Competence building and inter-firm dynamics
- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
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External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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